Contents

Important Notice to Constructors

★ The plans and instructions given in this manual **must** be read very carefully **at each step** of the construction process.

★ The order described here in which parts are made and assembled is the easiest, and should be followed exactly.

★ Particular care must be given to the relative positions of parts before they are welded.

★ Where materials are not available in the sizes specified in the manual, give serious thought as to how your substitution with material of a different size will affect the function of that part of the machine:
— Will the change weaken the finished machine?
— Will it make the machine less durable?
— Will this substitution alter other dimensions given elsewhere in the manual?

★ Where flat bar or plate of the specified thickness is not available, consider whether you could weld two thinner pieces together around the edges and use this in its place.

★ It is usually better to use a larger steel section than a smaller one.

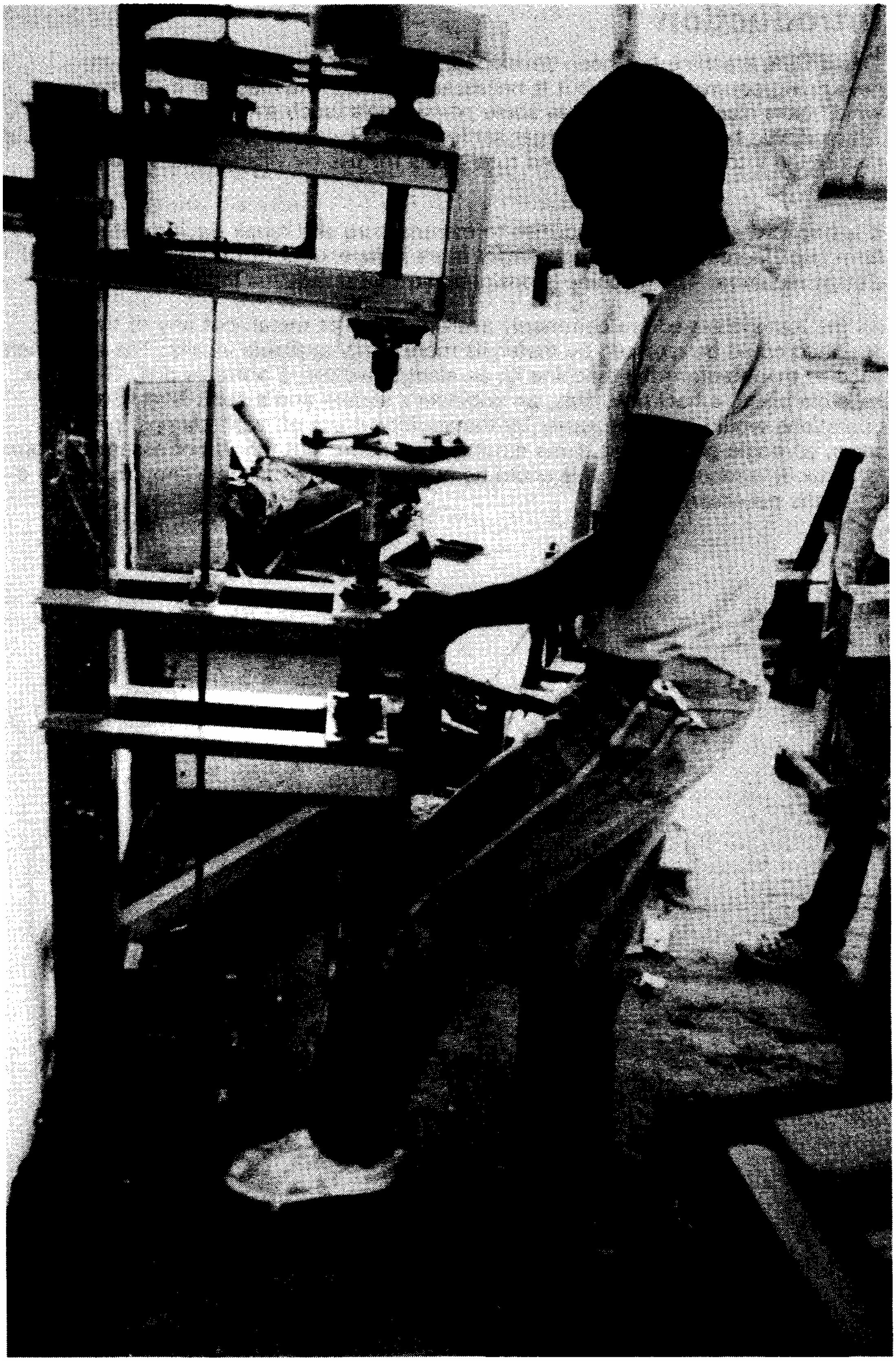
★ Components which slide together or rotate in one another should not be painted on those surfaces, and should be greased or oiled as the machine is assembled. Further oiling from time to time will also prolong the life of the machine.

★ At the front of this manual is a Check list. Please read it both before you build the machine and after you have completed the machine. If all the points listed are OK you will be well pleased with your machine!

Glossary

Explanations of some terms used in the text:

ϕ	=	diameter
Pitch ϕ	=	sometimes called 'pitch-circle diameter' (P.C.D.), this means the diameter of a circle on which a series of holes are drilled, usually equi-spaced.
OD	=	outside diameter.



Description

The machine consists of five main areas:

A Frame

B Drive-shaft sub-assembly

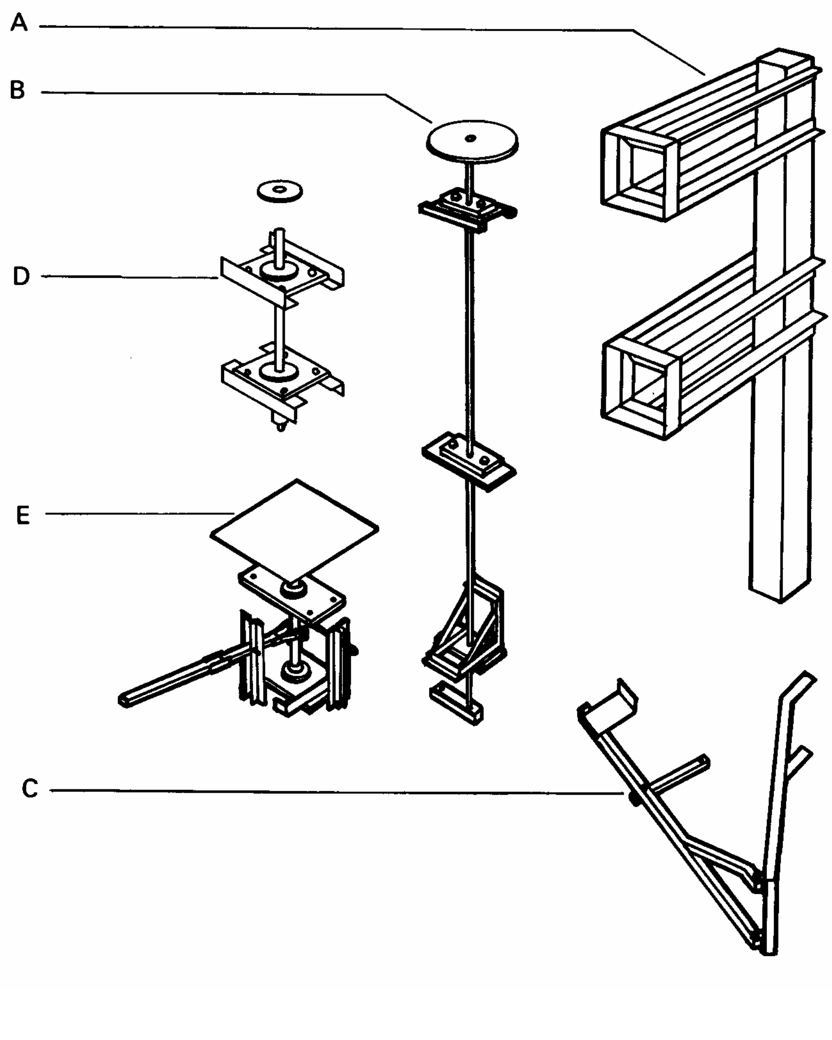
C Foot-push sub-assembly

D Spindle sub-assembly

E Table sub-assembly

The drill rotation is acquired by pushing the foot-push back and forward, which operates a crank mechanism causing the drive-shaft to rotate. A large pulley is attached to the drive-shaft and transmits the rotation to a small pulley, on top of the drill spindle, via a V-belt. At the other end of the drill spindle, which runs in two self-aligning ball bearings, is the chuck, which is attached to the spindle by a thread.

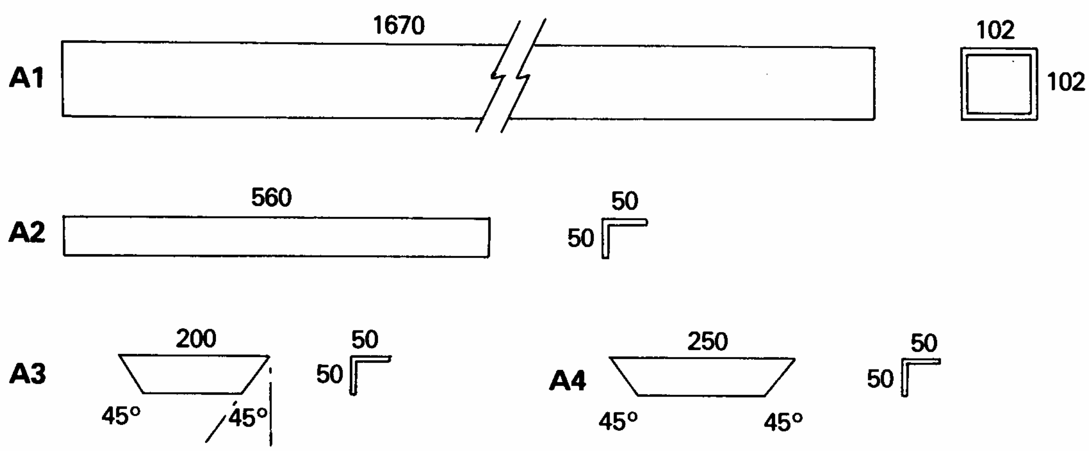
The vertical feed action is obtained by a lifting lever, which acts on a pin passed through the table tube. Pushing the lever down raises the table, and gravity returns it to the original position.

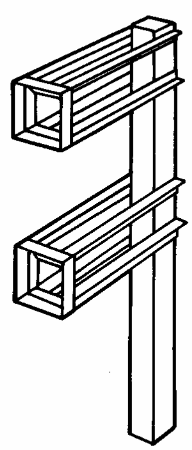


Construction

FRAME

Part	Name	Quantity	Dimension (mm)
A1	Pillar	1	1,700 × 100 × 100 MS RHS (RHS = Rectangular Hollow Section)
A2	Cantilevers	8	560 × 50 × 50 MS angle
A3	End pieces — horizontal	4	200 × 50 × 50 MS angle
A4	End pieces — vertical	2	220 × 50 × 50 MS angle
		2	250 × 50 × 50 MS angle





completed frame

The frame is designed around a central pillar, which can be any rigid section steel, such as a rolled steel joist (RSJ), but if it differs significantly in size to the 102mm square section suggested, some dimensions will have to be changed accordingly. The eight cantilevers are welded to the pillar and are kept rigid by two sets of four angles welded on at their outer ends.

The two end-pieces should be constructed to the sizes shown in Figure 1. Clamp up each end-piece using off-cuts of angle (check off-cuts for squareness, see Figure 2) and either G-clamps or lockable pliers (visegrips, etc.), see Figure 3. Once the end-pieces are tacked up, check that they are 'square' again and then weld up on the inside (Figure 4) to avoid having to grind of excess weld later on.

Figure 1.

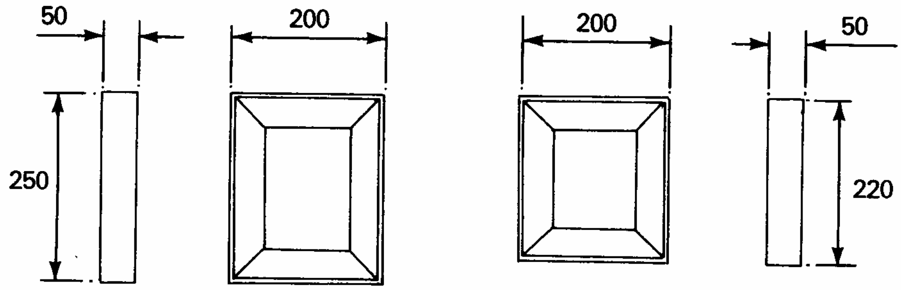


Figure 2. Check angles for squareness

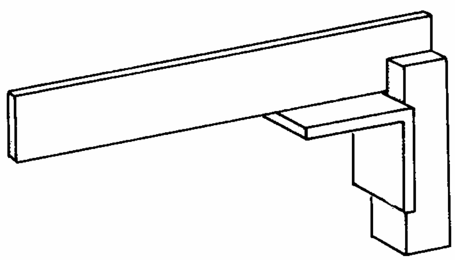


Figure 3. Clamp angles and tack

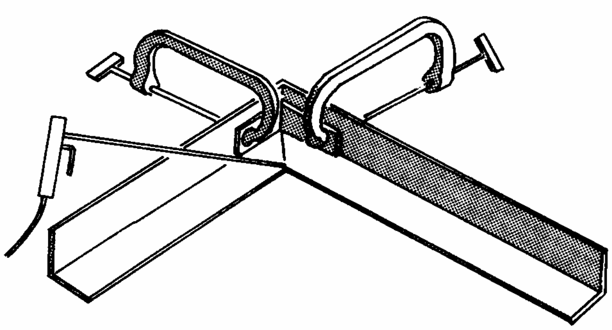
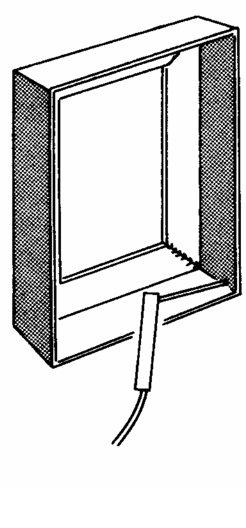


Figure 4. Weld angles on 'inside'



Working with the pillar on the ground, clamp on one of the cantilevers approximately 30mm from the top (Figure 5), and check that the cantilever is square to the pillar (Figure 6). Also check that the cantilever is clamped on the right way, Figure 7, then tack in place.

Figure 5. Clamp cantilever 30mm from top

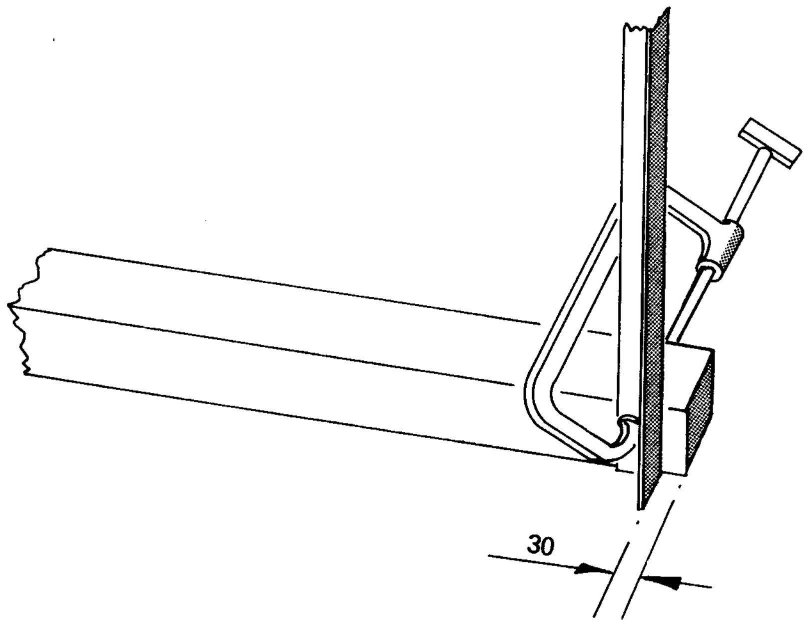
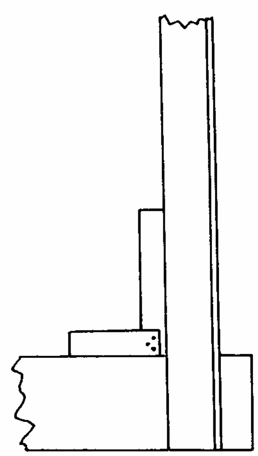


Figure 6. Check cantilever for squareness



On the same side of the pillar, clamp the next cantilever on (Figure 7) and using a ruler, check that the measurements, at both ends of the cantilever, are the same. This will ensure that they are parallel. The end-piece may be clamped on to keep the cantilever in place while it is being tacked on.

Figure 7. Arrangement of cantilevers

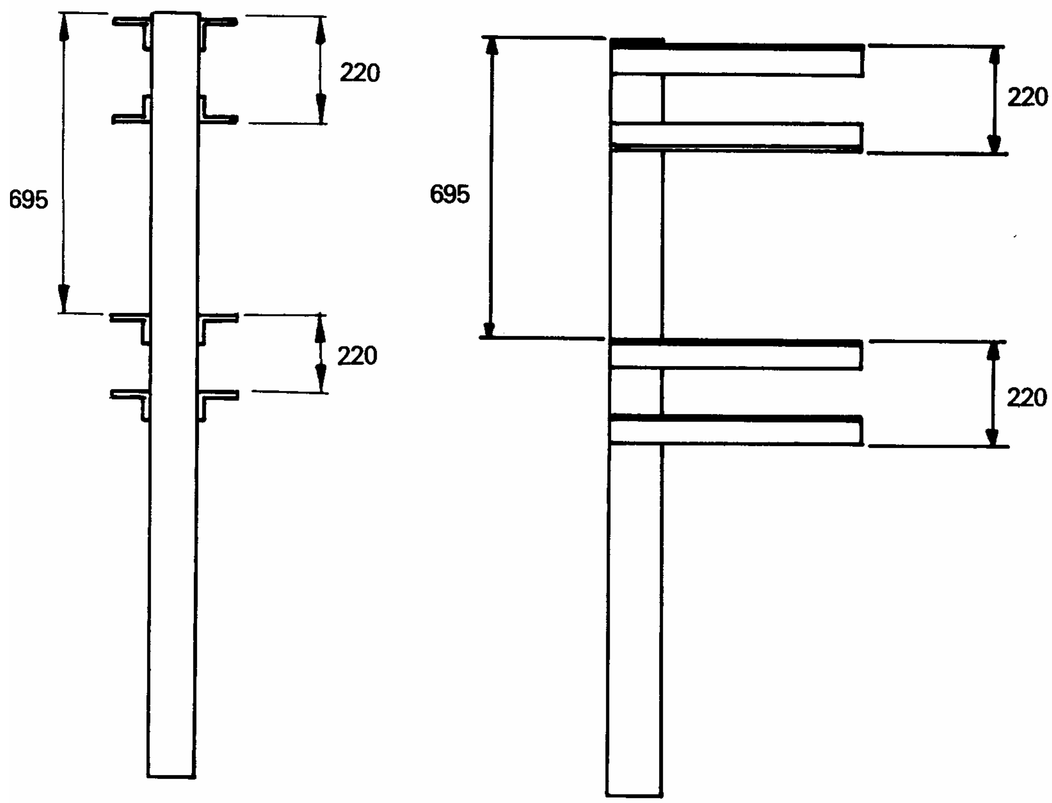
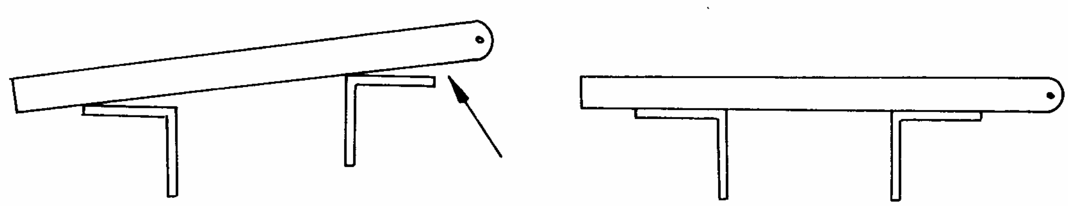


Figure 8. Check to ensure cantilevers are level



Now clamp the two corresponding cantilevers on the other side of the pillar, placing a straight edge across their top surfaces at both ends, to ensure that they are level (Figure 8). Tack on these cantilevers also. Tack on the end-piece, with the flat side of the angle towards the pillar. Now weld-up, taking care not to put too much heat on any one area. Work on alternate sides of the pillar to even out stresses and avoid distortion.

Now repeat this process with the lower set of cantilevers, starting with the uppermost cantilever, 695mm from the top of the pillar (Figure 7).

DRIVE-SHAFT SUB-ASSEMBLY

Part	*Name*	*Quantity*	*Dimension (mm)*
B1	Drive-shaft	1	1,640 × ϕ16 Bright MS
B2	Sleeve	1	90 × ϕ30 Bright MS
B3	Upper bracket — RHS	2	200 × 30 × 30 MS RHS
B4	Upper bracket — angle	2	80 × 25 × 25 MS angle
B5	Middle bracket	1	200 × 50 × 5 MS flat bar
B6	Lower bracket — angle	2	320 × 25 × 25 MS angle
B7	Lower bracket — end	2	80 × 50 × 25 MS angle
B8	Lower bracket — stay	2	170 × 20 × 5 MS flat bar
B9	Wood bearing	3	80 × 40 × 20 Hard wood
B10	Crank	1	75 × 25 × 25 × 3 MS RHS
B11	Pulley	1	Pitch Ø 200 Type A

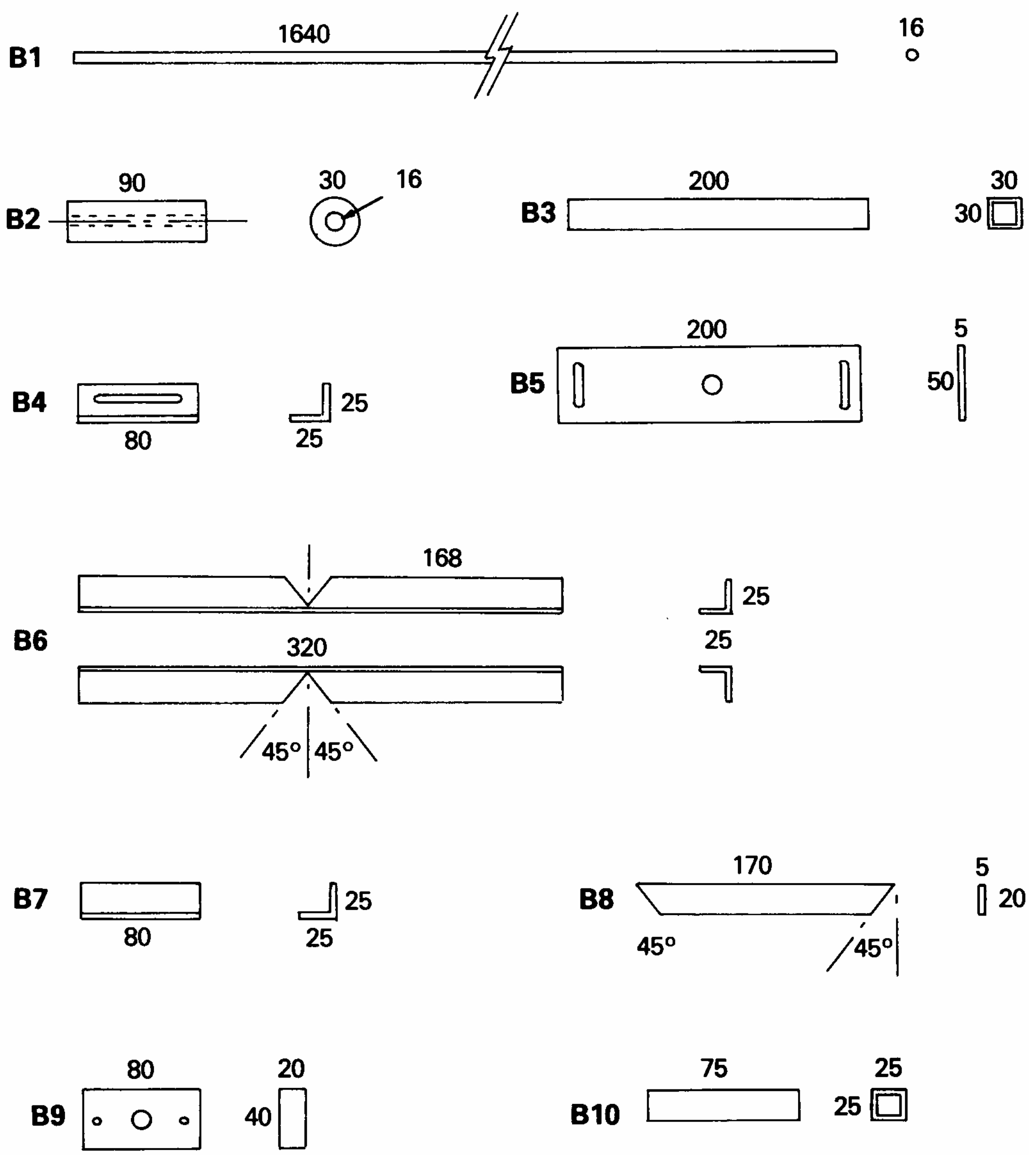
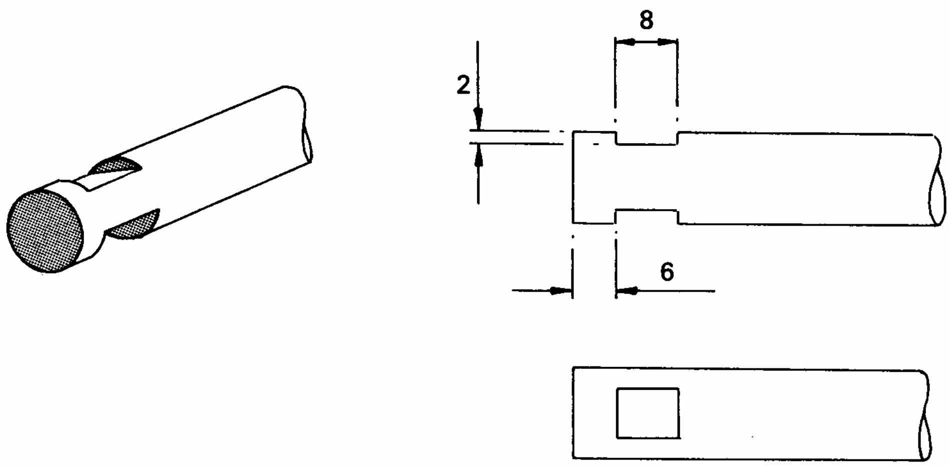


Figure 9. The flats on drive-shaft



Driveshaft Sub-Assembly

Cut the drive-shaft to length and file flat at one end, see Figure 9. Take a 30mm diameter sleeve and drill a 12mm diameter hole to accommodate the drive-shaft, either on a lathe or a drilling machine, using a vee block support, Figure 10. Slide the sleeve onto the drive-shaft (at the opposite end to the flats), and weld according to Figure 11.

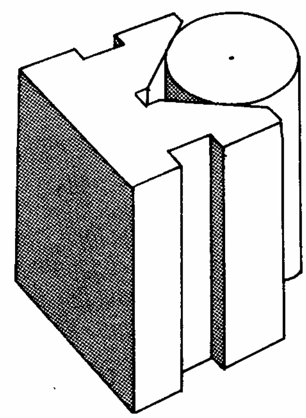
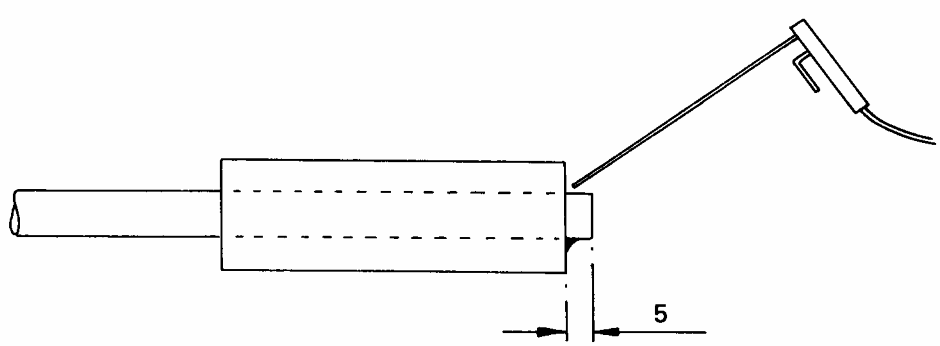


Figure 11. Weld sleeve to drive-shaft, 5mm from the top



Referring to Figure 12, mark a line 10mm in from the open edge of parts B4, mark and centre punch at 15mm from both ends, then at 6mm intervals between the two marks. Centre punch and pilot drill a 3mm diameter hole, (the small drill helps to prevent the larger drill from 'wandering'), then drill to a 6mm diameter. Using a hacksaw and small file, complete the slot. Repeat with the other B4 angle.

Figure 12. B4 upper bracket angle

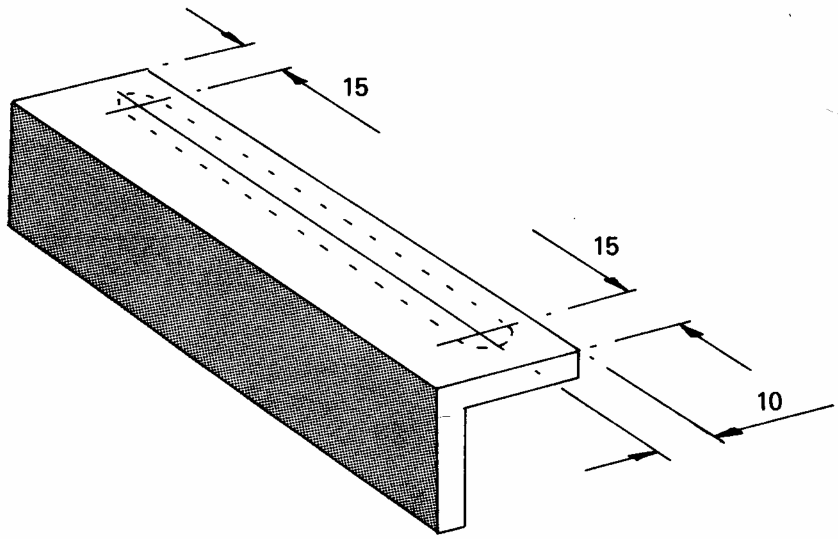
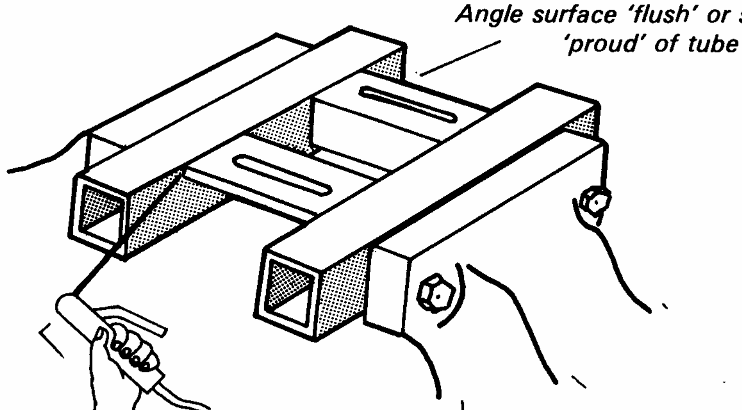
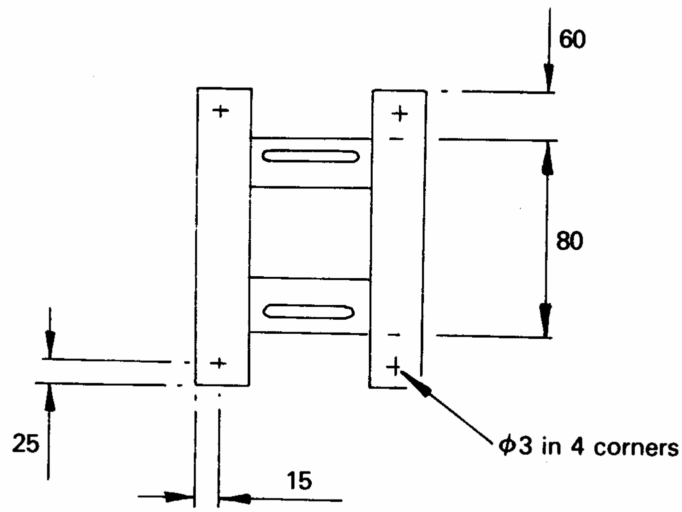


Figure 13. Clamp up the top bracket



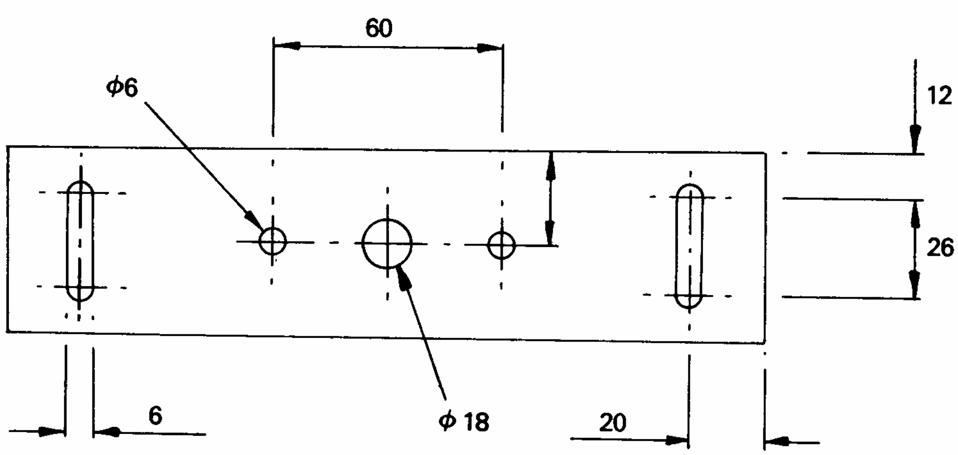
Now clamp the two angles B4 and tubes B3 in a vice, (Figure 13), or sash clamps, following the dimensions in Figure 14. Tack together and then weld on to the underside (Figure 13). Drill the four 3mm diameter holes according to Figure 14.

Figure 14. The top bracket



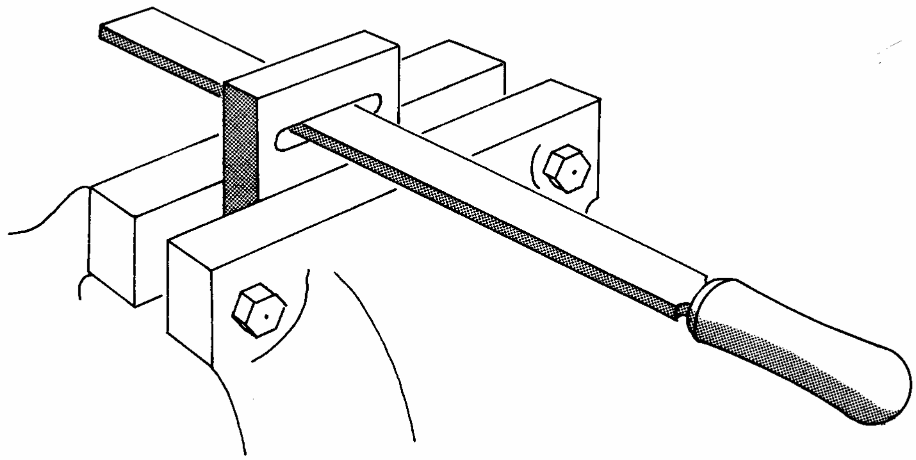
Mark the centre of the middle bracket B5 and drill a hole just bigger than the drive-shaft, e.g. 13mm (Figure 15). Mark a line 20mm from each end, and on that line, 12mm from each side, centre punch. Now mark and centre punch three intermediate points 6mm apart, on that line, and drill all five holes at both ends, 3mm diameter, then 6mm. Also drill the two other holes shown in Figure 15.

Figure 15. The middle bracket



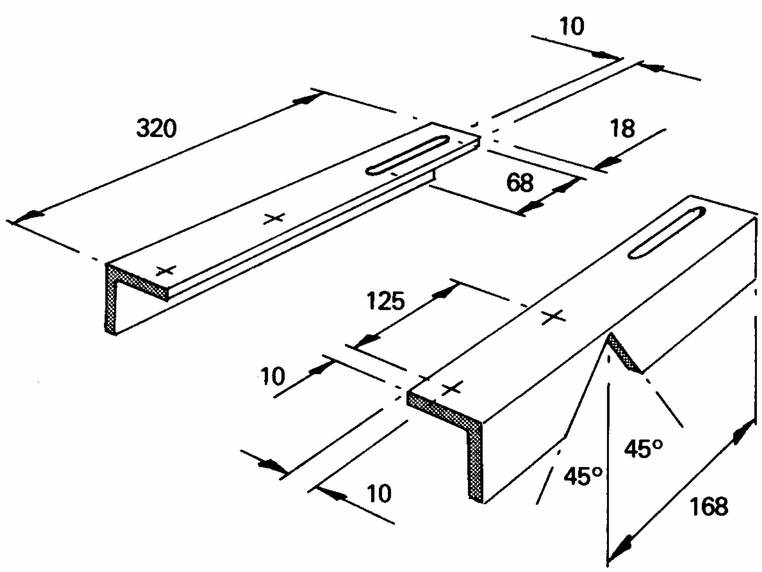
Now file out the slot as before (Figure 16).

Figure 16. File the slot in the middle bracket



On the lower bracket angle B6, mark out the position of the slot (Figure 17) and centre punch at 6mm intervals along that line. Drill a 3mm diameter hole, then a 6mm diameter, and file the slot out, as before. Mark and centre punch the other two holes shown in Figure 17. Repeat for second angle, noticing that they are 'opposite handed'.

Figure 17. Bottom bracket angles



Mark out and hacksaw the 90° included angle vee (Figure 17), then fold the bracket in a vice (Figure 18). Check that it is square, then position the bottom bracket-stay B8 as in Figure 19. Clamp one end whilst the other end is tacked. Tack the other end, weld up, and then repeat on the other bracket-angle.

Figure 18. Fold up bracket in a vice

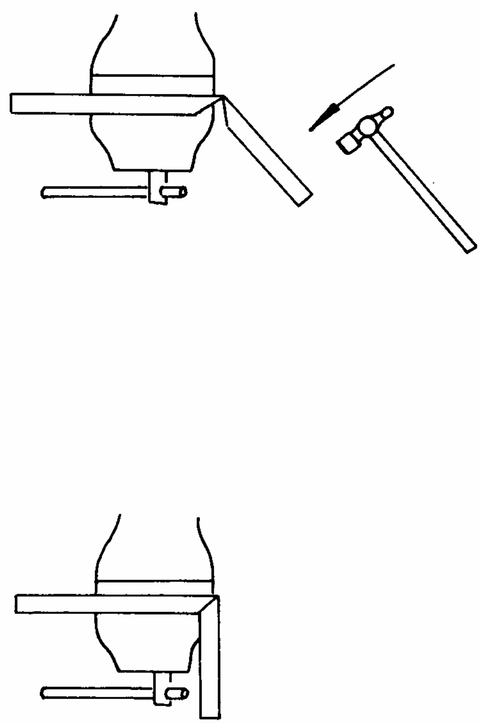
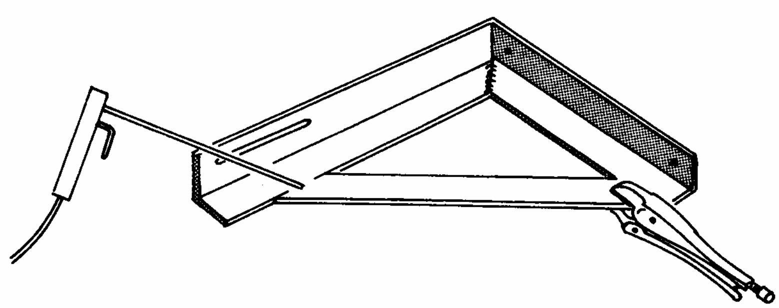


Figure 19. Tack stay to bracket



Clamp one of the lower bracket-ends B7 as in Figure 20, check that it is square, then tack in place. Clamp the other lower bracket-angle B6 (Figure 21), check that the distance between the slot centres is 60mm, and tack. Now tack on the remaining end-piece B7 at the top of the bracket. Weld up the completed lower bracket (Figure 21).

Figure 20. Clamp the end-piece and check for 'squareness'

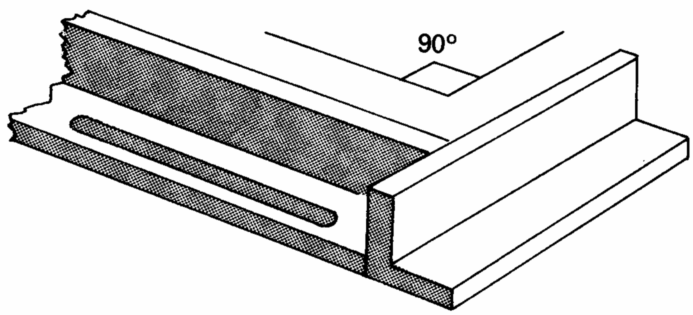
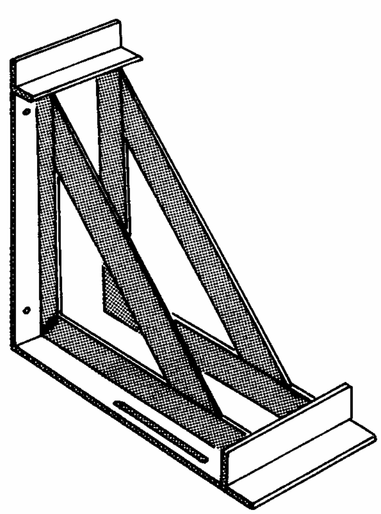
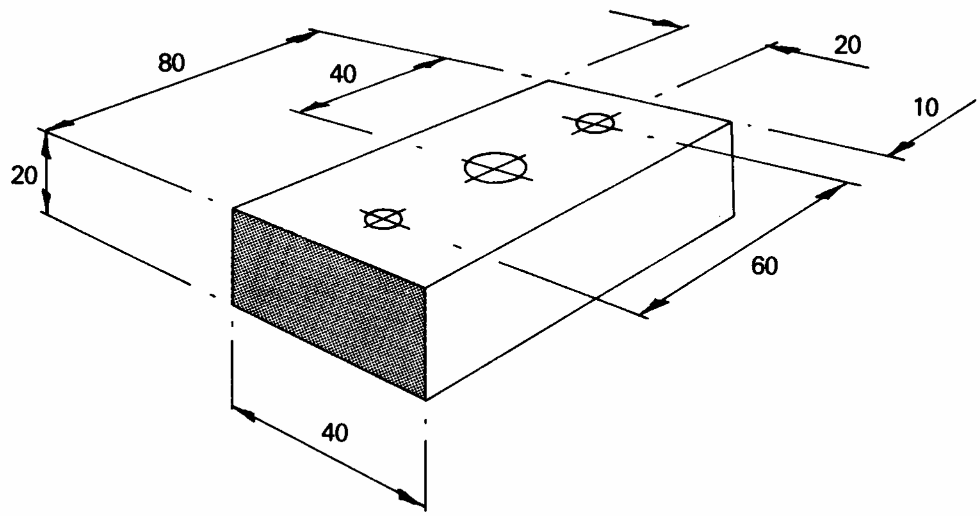


Figure 21. Weld up the complete lower bracket



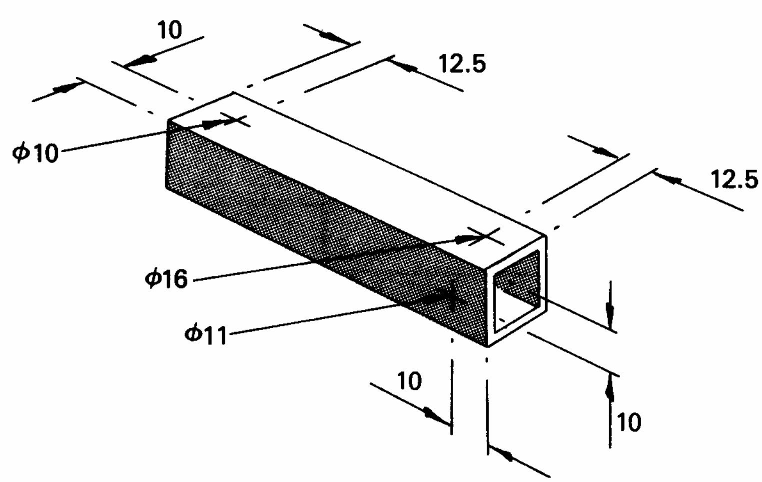
The wood bearings B9 should be made of heavy hard wood, such as mahogany or teak, to the sizes indicated in Figure 22. The centre hole is drilled 16mm diameter to suit the drive-shaft. The outer two holes are drilled 6mm. The two bearings to be fitted to the lower and middle bearings need only the bottom surface flat, to ensure correct seating on the bearing brackets. The bearing for the upper bracket should have top and bottom surfaces flat and parallel, to ensure the correct running of the large pulley. Even the dense woods are quite easily shaped with a file and abrasive paper placed on a flat surface (the drill table is ideal). The wood bearings should be soaked in oil for as long as possible (minimum two days). The oil will penetrate more thoroughly if it is first heated up.

Figure 22. Wood bearings



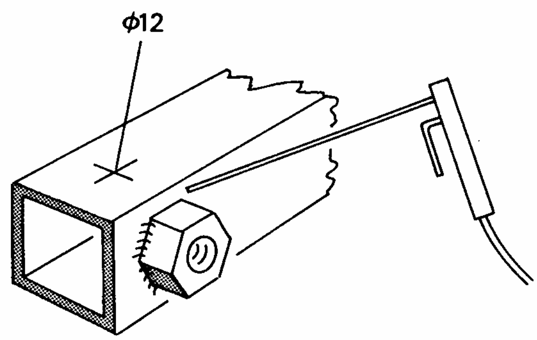
The crank B10 should be marked out according to Figure 23 and the hole positions centre punched. Drill all holes to 3mm diameter and then to size (except the 16mm hole).

Figure 23. Crank



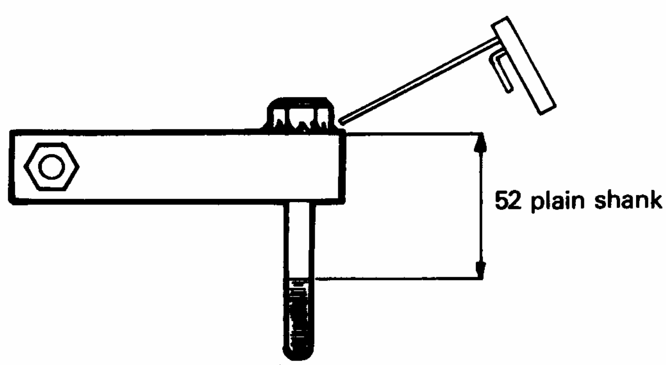
Now clamp on an M10 nut over one of the 11mm diameter holes, (Figure 24). Check that the nut is in line with the hole, and tack. Repeat with another nut on the other side of the crank. Then weld fully and drill the 16mm diameter hole to size.

Figure 24. Weld on M8 nut to the crank



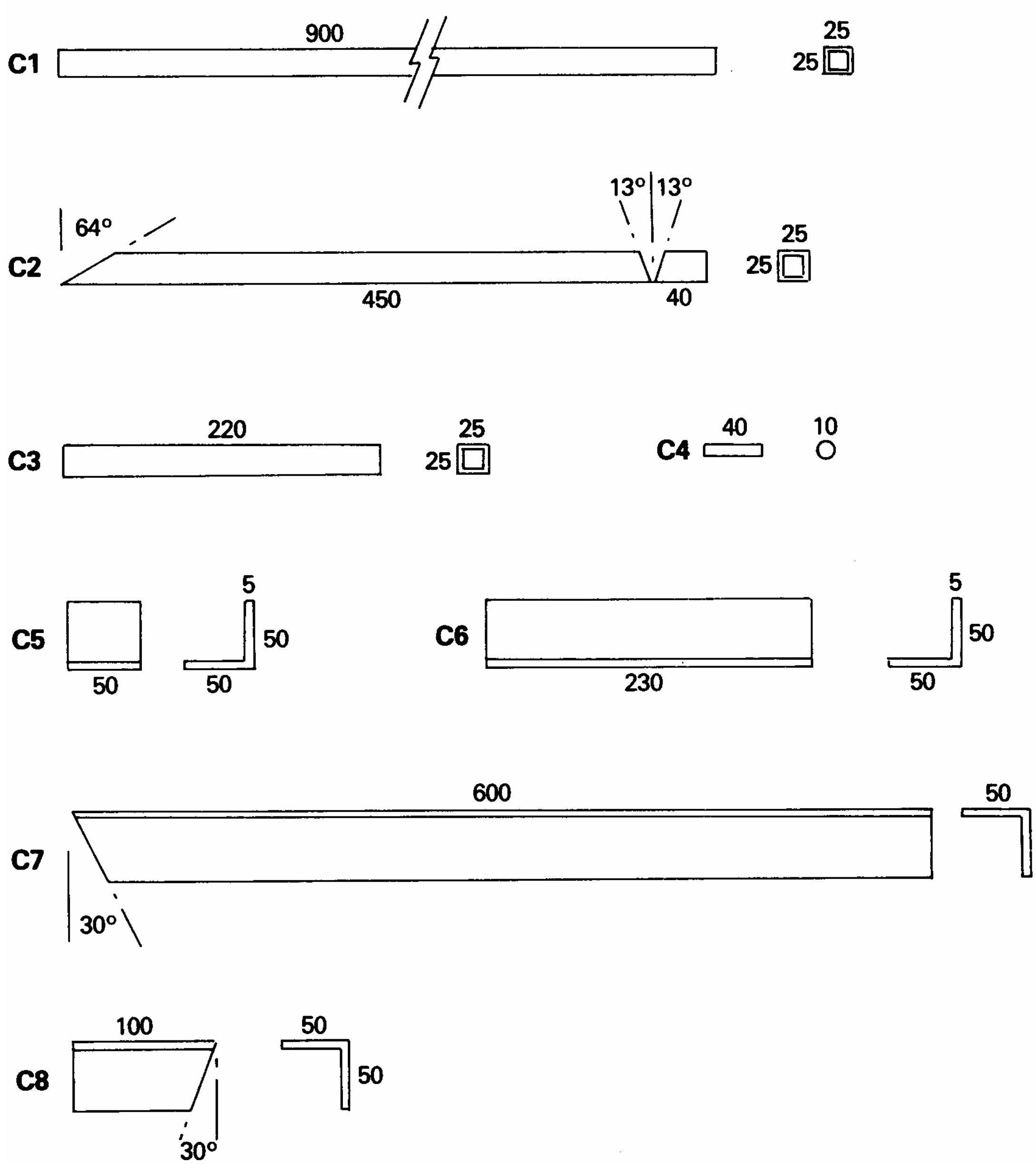
Pass an M10 bolt, with a plain shank of approximately 52mm (Figure 25) through the 8mm diameter hole, and weld around the head.

Figure 25. Weld bolt to crank



FOOT-PUSH ASSEMBLY

Part	Name	Quantity	Dimension (mm)
C1	Foot-push	1	900 × 25 × 25 MS RHS
C2	Foot-push — stay	1	450 × 25 × 25 MS RHS
C3	Connecting rod	1	220 × 25 × 25 MS RHS
C4	Pivot pin	2	40 × ϕ × 10 MS bar
C5	Pin support	2	50 × 50 × 50 MS angle
C6	End-angle	1	225 × 50 × 50 MS angle
C7	Foot-push support	2	600 × 50 × 50 MS angle
C8	Foot-push support	2	100 × 50 × 50 MS angle
C9	Foot steady	1	185 × 120 × 1.5 MS sheet



Foot-push Sub-Assembly

Fold up part C2 of the vee, and weld. Position C1 and C2 as shown in Figure 26, and check their ends are flush, using a large square. Check the dimensions and then weld together.

Figure 26. Weld foot-push.

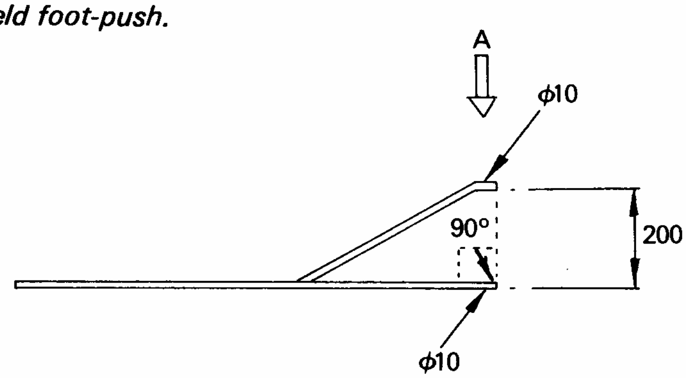


Figure 27. View A of top of stay

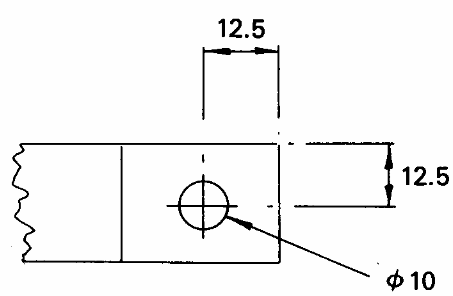
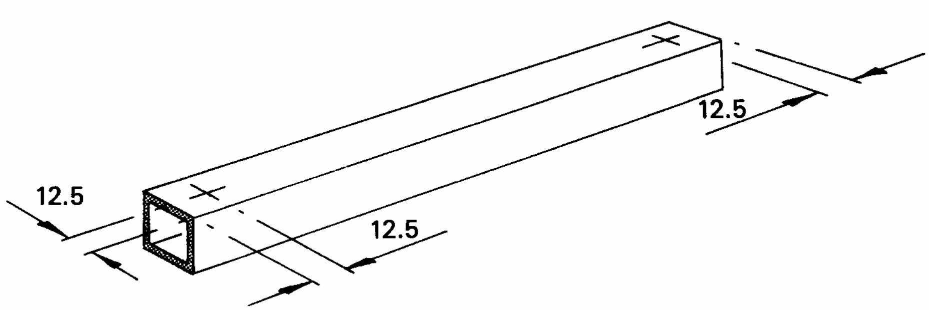


Figure 28. Con rod



Drill 10mm diameter in the top stay, (Figure 27) and a corresponding hole in the bottom tube. Mark out the con rod, C3 (Figure 28), centre punch and drill a 10mm diameter hole right through. Mark out both pivot pin supports C5, (Figure 29). Centre punch and drill to fit pivot pins C4 (10mm diameter). One of the angles only must be sawed and filed to clear the foot-push (Figure 30).

Figure 29. Pivot pin support

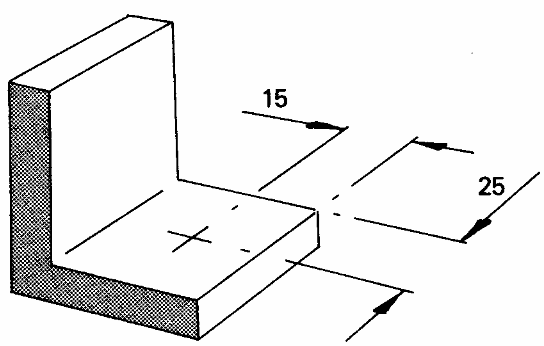
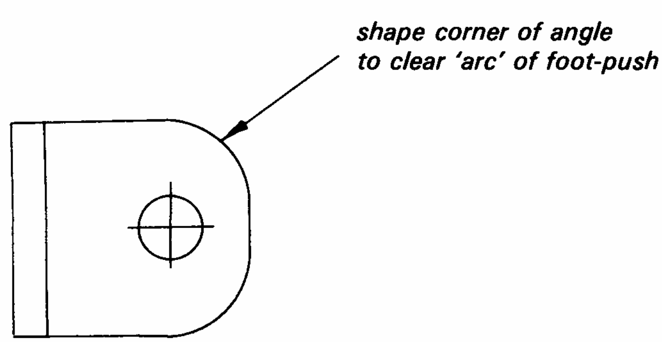


Figure 30. Top pin support, shaped



Insert pivot pins in supports (Figure 31) with 5mm protruding, and weld on the 5mm side. Then clamp the supports to the end-angle C6 (Figure 31) and weld. Weld up the foot-push support angles C7 and C8 (Figure 32) on a flat surface, to avoid twisting.

Figure 31. Weld pivot pin supports to end-angle C6

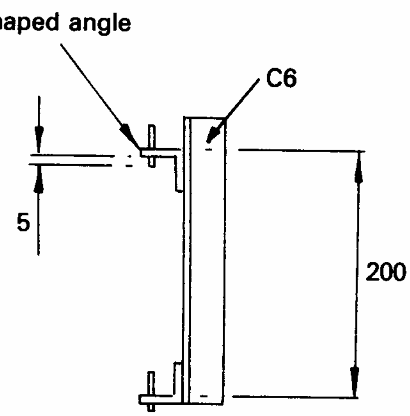
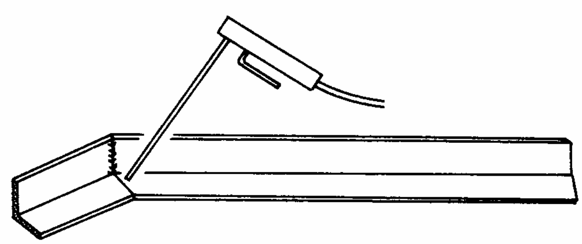
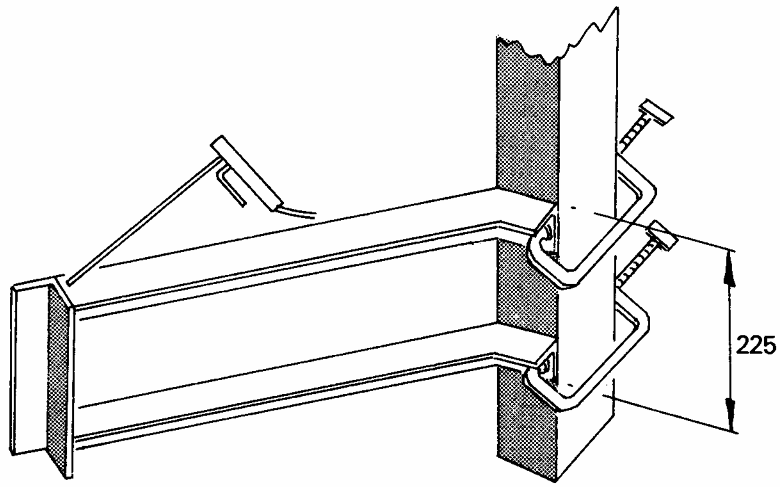


Figure 32. Weld up support angles on a flat surface



Clamp the foot-push supports to the pillar (Figure 33), and check the 225mm dimension. Clamp the end-angle C6 to the foot-push supports, using cut-off angles and vise grips. Then check 225mm dimension, and tack. Remove clamps and weld-up end-angle.

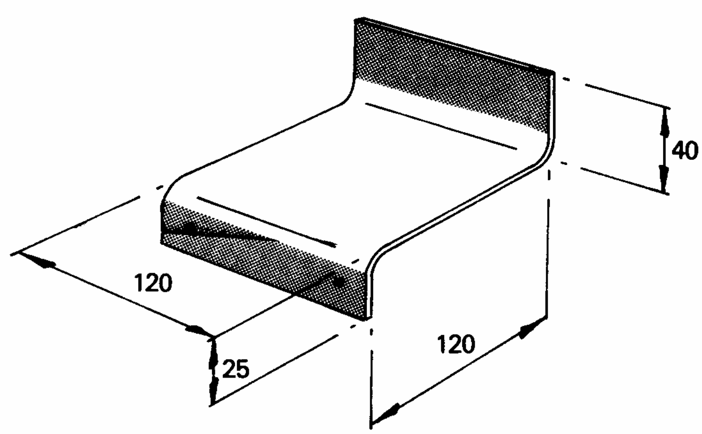
Figure 33. Weld end-angle to support angles



DO NOT WELD FOOT-PUSH SUPPORTS TO PILLAR YET!

On the foot-steady C9, mark a line 40mm from one short side and 25mm from the other short side, but on the opposite side (i.e. the underneath) of the plate. Fold up in a vice or sheet metal folders (Figure 34).

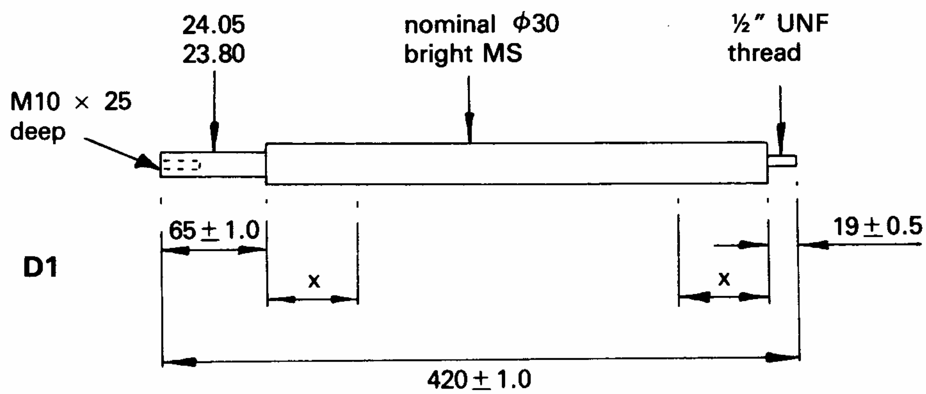
Figure 34. Fold up foot-steady



SPINDLE ASSEMBLY

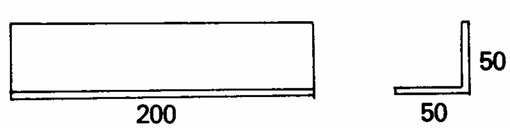
Part	*Name*	*Quantity*	*Dimension (mm)*
D1	Drill spindle	1	420 × ϕ 30 bright MS
D2	Bearings	2	Self aligning, flange type, nominal 30mm diameter, grub screw lock. SKF FY 30 SD
D3	Bearing seats	4	200 × 50 × 50 MS angle
D4	Pulley	1	Pitch ϕ 80 Type A 30 Taper lock
D5	Chuck	1	Jacobs Multi-craft 0-13mm ½" UNF internal thread

D1



½" UNF 20 threads/inch e.g. pitch 1.27mm, OD 12.7mm. 60° included angle.

D3



Spindle Sub-Assembly

Turn the drill spindle, D1, on a lathe to the dimensions given on the opposite page. Check that the bearings D2 fit on the 30mm shaft. If they do not, turn the shaft to between 29.95mm and 30.00mm for dimension x = 55mm.

Note: SKF FY30SD bearings are the most suitable bearings, as the Japanese FYH and other types have large hole centre distances and large (16mm diameter) bold holes, which make them difficult to locate in the frame.

The following dimensions are for SKF, so if other bearings are being used, the dimensions will have to be changed to suit.

Mark out the bearing seats D3 (Figure 35). Centre punch and drill outer holes 3mm diameter and inner holes 10mm diameter.

To locate the bearing centrally:
given that the bearing fixing hole centres = 82mm (Figure 3) and the seat D3 = 200mm:

200 − 82 = 118mm, and 118 ÷ 2= 59mm; therefore 59mm from one edge will centralize the bearing, (Figure 36).

Figure 35. The bearing seats

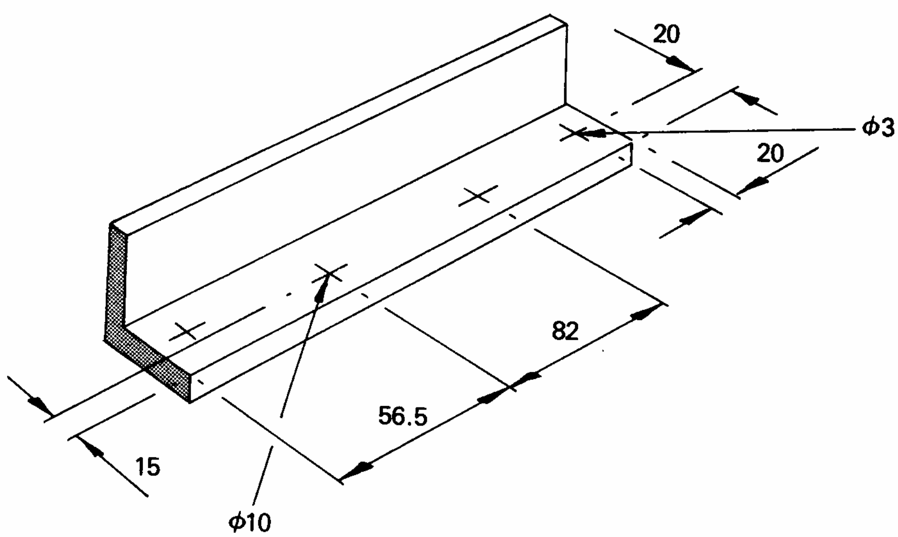


Figure 36. SKF Type FY30 SD bearing.

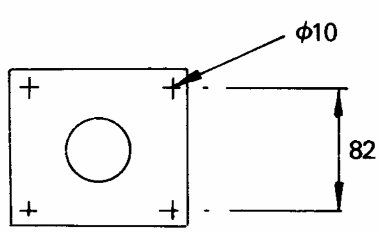


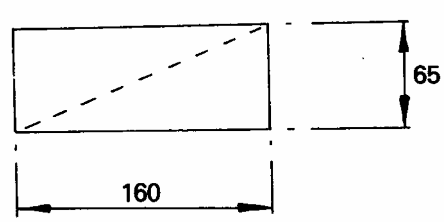
TABLE ASSEMBLY

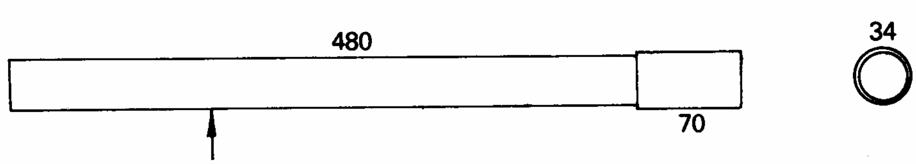
Part	Name	Quantity	Dimension (mm)
E1	Table — tube	1	480 × ϕ 34 × 3 wall MS pipe
E2	Table — ribs	4	165 × 65 × 5 MS flat bar
E3	Table — top	1	300 × 250 × 10 MS plate
E4	Bearing	2	25 × ϕ 51 nylon or steel
E5	Bearing seat	2	20 × ϕ 75 MS
E6	Bearing plate	2	200 × 95 × 5 MS flat box
E7	Handle	1	175 × 25 × 25 MS RHS
E8	Handle — extension	1	300 × 25 × 25 MS RHS
E9	Handle — forks	2	85 × 25 × 5 MS flat bar
E10	Handle — side plates	2	102 × 25 × 5 MS flat bar
E11	Handle — bottom plate	1	35 × 25 × 5 MS flat bar
E12	Handle — pivot	2	225 × 50 × 50 MS angle
E13	Pin guides	2	165 × 25 × 25 MS angle
E14	Pin guide — steady	1	110 × 30 × 5 MS flat bar
E15	Pin guide — steady	1	40 × 30 × 5 MS flat bar
E16	Clamps	2	130 × 40 × 10 MS flat bar
E17	Thumb bar	2	50 × ϕ 10 bar

Table Sub-Assembly

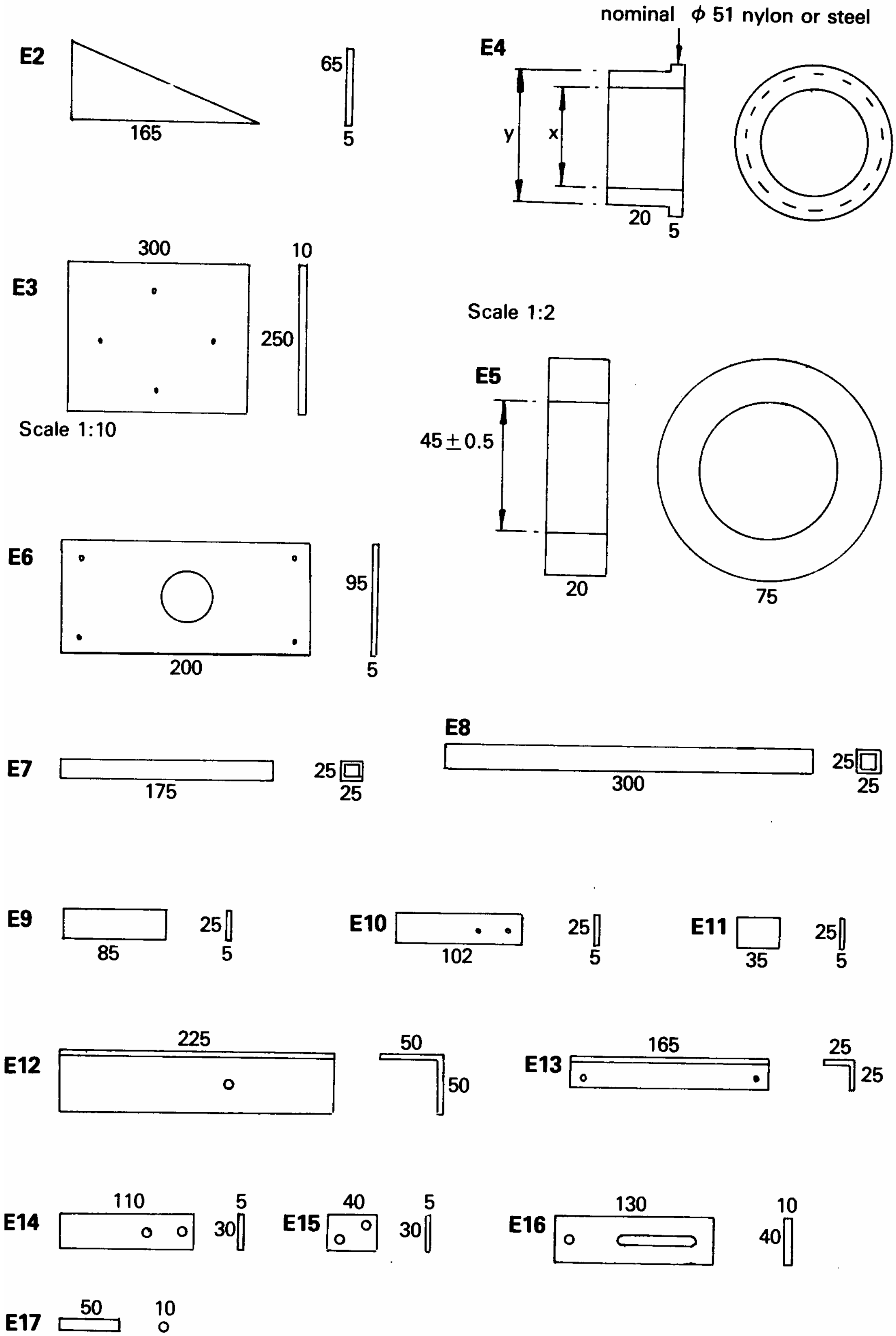
Skim table tube E1 on lathe to achieve true 'roundness', see below. Then cut a piece of 160 × 65 × 5mm flat MS diagonally to make two table ribs E2, (Figure 37). If table top E3 is being made of 10mm plate it must be flame cut, but if thinner (6mm) it may be cut with a hack-saw blade and holder, or an electric jig saw if available.

Figure 37. Table ribs E2





this diameter skimmed to achieve roundness



E2
165
65
5
E4
nominal ϕ 51 nylon or steel
y
x
20
5
E3
300
10
250
Scale 1:10
Scale 1:2
E5
45 ± 0.5
20
75
E6
200
95
5
E7
175
25
25
E8
300
25
25
E9
85
25
5
E10
102
25
5
E11
35
25
5
E12
225
50
50
E13
165
25
25
E14
110
5
30
E15
40
5
30
E16
130
10
40
E17
50
10

Mark, centre punch and drill 11mm diameter holes in the table for clamp nuts, (Figure 38). Tack four M10 nuts on the underside of the table, over the holes. These can be held in place by bolts, from the other side, whilst welding. From the centre of the table scribe a circle 35mm in diameter to assist in placing the table tube E1. The tube should be clamped in place either by sash clamps and off-cuts (Figure 39), or by a threaded rod down the centre of the tube (Figure 40). (Drill out the table centre first.) An alternative to a threaded bar is an M6 bolt welded on both ends of a plain bar. Check that the table tube E1 is square to the table top E3 (Figure 40) in at least three places. When correct, tack the tube and check again, straightening if necessary. Weld on the tube working on alternate sides to minimize distortion.

Figure 38. Position of 11mm diameter holes in table top

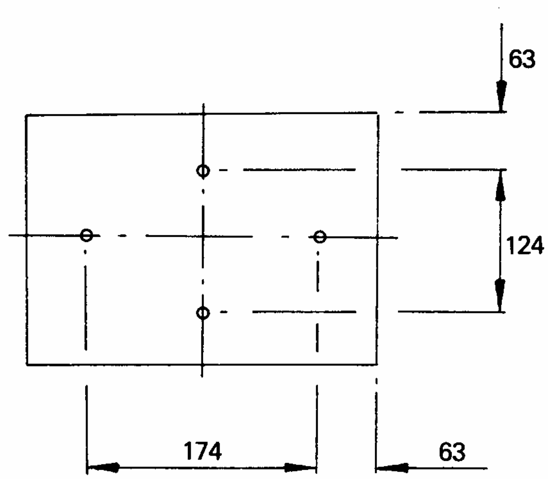


Figure 39. Clamp tube to top with sash clamps

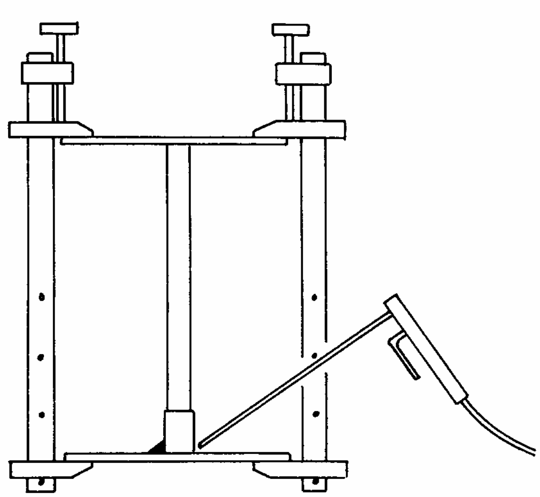
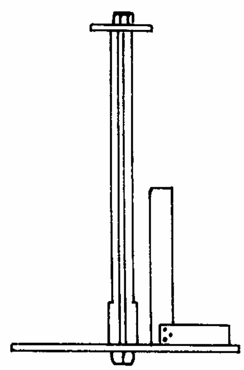


Figure 40. Clamp tube to top with threaded rod



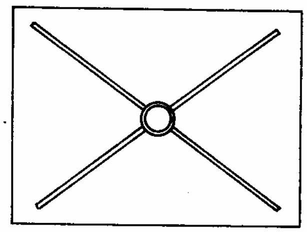


Figure 41. Position table ribs

Position four table ribs E2, (Figure 41), and tack. When tacked, put two short (10mm) welds each side of each rib and one on the tube (Figure 42). Weld on alternate sides of the table to minimize distortion. Mark and centre punch holes in the table tube (Figure 43). Drill through 10mm diameter holes for table pins, making sure the holes are central on the tube axis.

Figure 42. Weld up table

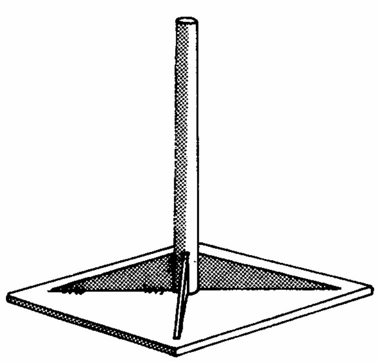
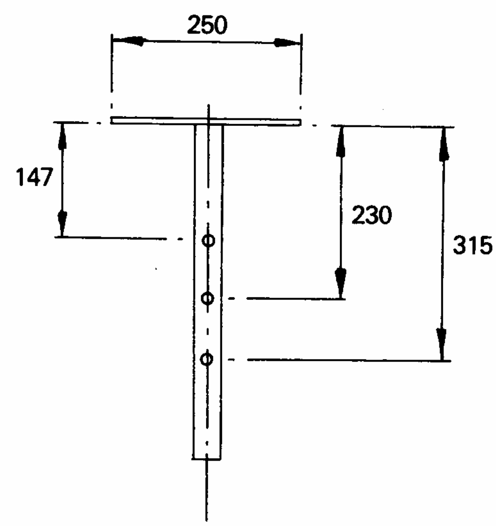


Figure 43. Drill table tube



The bearing seat E5 should be machined as on the scale drawing on page 29, and the actual dimension noted. Measure also the outside diameter of the table tube, and note. Now machine the bearing E4 dimension *x* to the size of the table tube, plus between 0.01mm and 0.05mm. So if the table tube measures 33.50mm, dimension *x* should be between 33.51mm and 33.55mm.

Now machine the bearing dimension *y* to the size of the bearing seat bore plus between 0.04mm and 0.07mm. So if the bearing seat bore measures 44.80mm, then dimension *y* should be between 44.84mm and 44.87mm.

Mark out the centre of bearing plate E6 and centre punch. Mark out and centre punch the four corner holes as well, (Figure 44). Scribe a circle 34mm diameter from the centre of the plate and with a pair of dividers set at 7mm, 'step' around the circle and centre punch each mark. On one plate drill all holes 3mm and on the other plate drill all the holes 3mm excluding the corner holes. Now drill all the centre holes 6mm, knock out the centre and file it until approximately round. If the centre is difficult to remove, use a hammer and cold chisel to break the 'bonds' between the holes (Figure 45). Repeat for the second plate.

Figure 44. Bearing plate E6

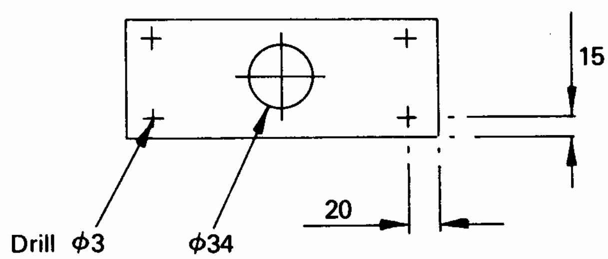
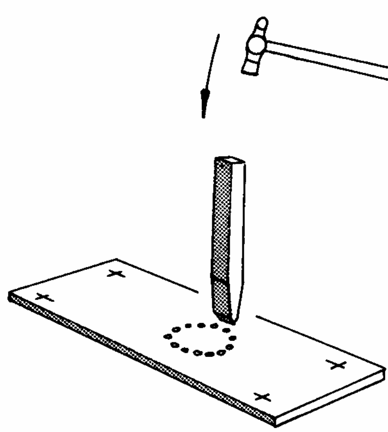


Figure 45. Use a hammer and cold chisel to break the 'bonds'



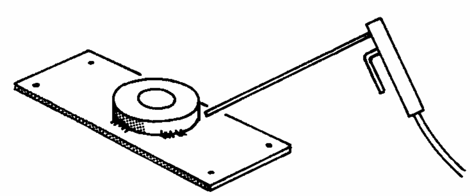
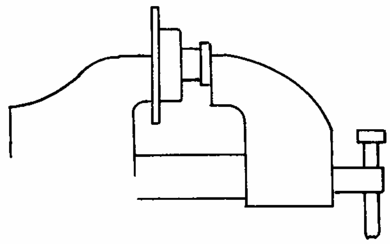


Figure 46. Tack weld the seat to the plate

Centre the bearing seat E5 on plate E6, clamp firmly and tack, (Figure 46). Repeat for second plate.

When cool, press in the nylon or steel bearing E4, using a vice (Figure 47). Take care not to press the bearing in at an angle.

Figure 47. Press in nylon brush



Mark handle E7, (Figure 48), centre punch and drill to an 8mm diameter right through. Mark handle extension E8, (Figure 49), centre punch and drill right through.

Figure 48. Handle E7

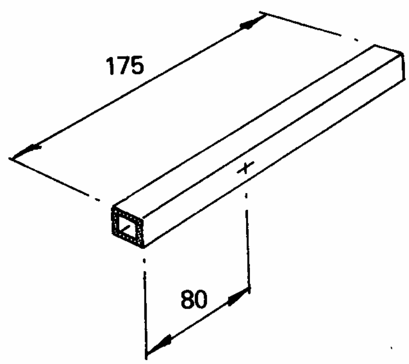
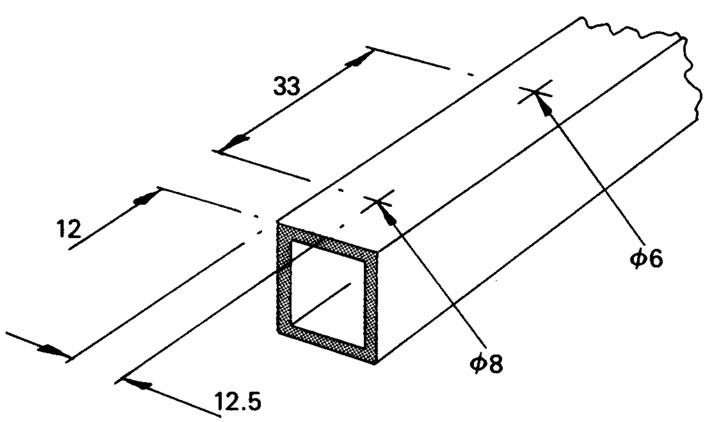


Figure 49. Handle extension E8



Scribe a line 35mm from each end, but on the opposite sides of the handle forks E9. Either in a vice or sheet metal folder, fold to the shape in Figure 50. Mark and drill one only of the side plates E10, according to Figure 51. Clamp the handle side plates E10 in position on the handle E7 as shown in Figure 52, and tack in place. Drill 6mm and 8mm holes through the opposite side plate E10 as shown Figure 52.

Clamp bottom plate E11 in place (Figure 53), and tack. Position the forks E9 on the handle E7 (Figure 54), and tack. Now weld up all the tacked handle pieces.

Figure 50. Fold up handle forks E9

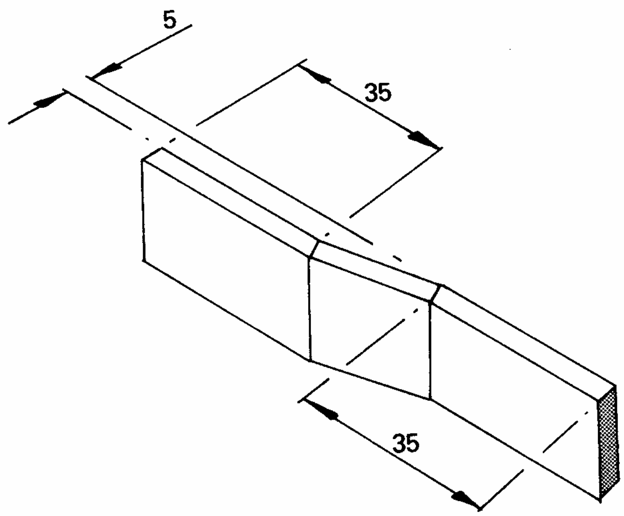


Figure 51. Side plates E10

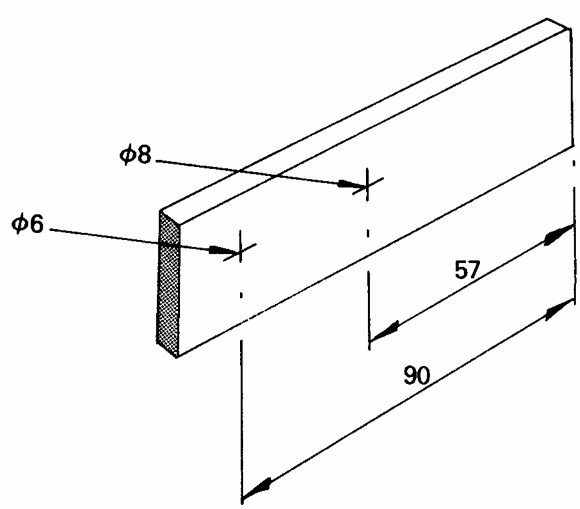


Figure 52. Tack on side plates, and drill through

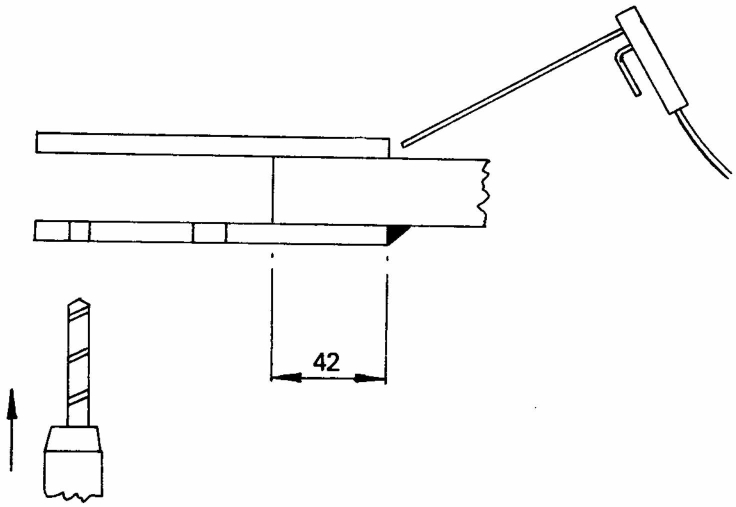


Figure 53. Clamp and tack bottom plate E11

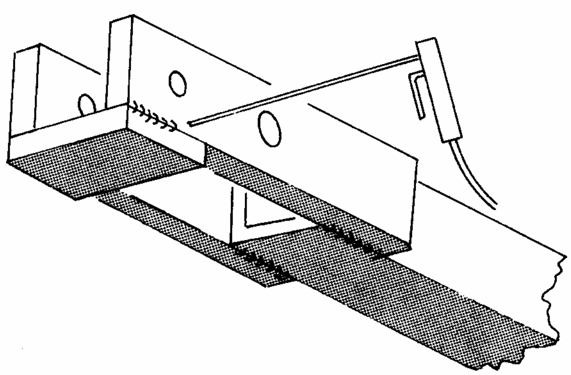
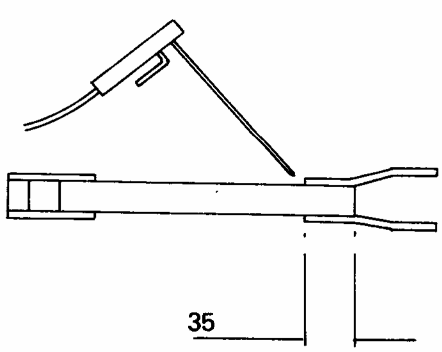


Figure 54. Tack forks to handle



Mark out, centre punch and drill to size all the holes in parts E12, (Figure 55).
Note: the parts are 'opposite handed'.

Clamp pieces E14 and E15 together (Figure 56), check for squareness, and tack. Remove clamps and weld.

Figure 55. Handle pivots E12

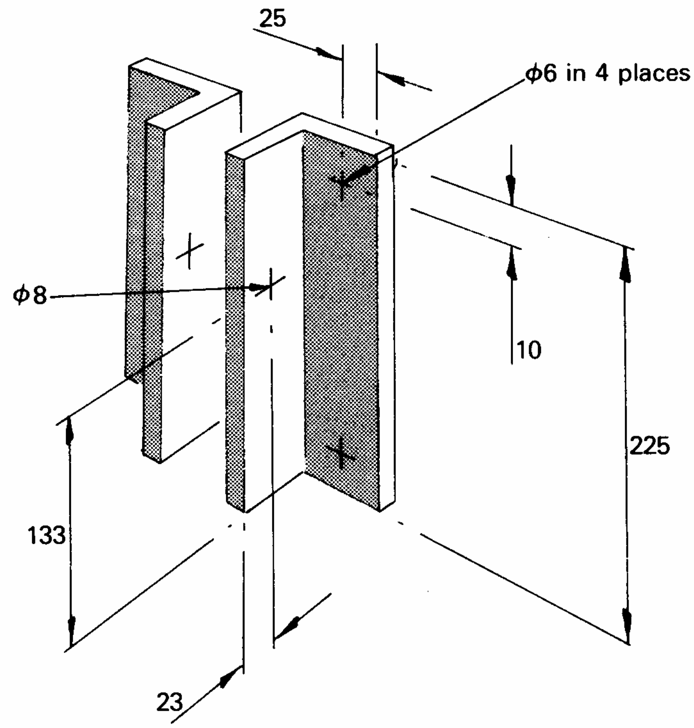
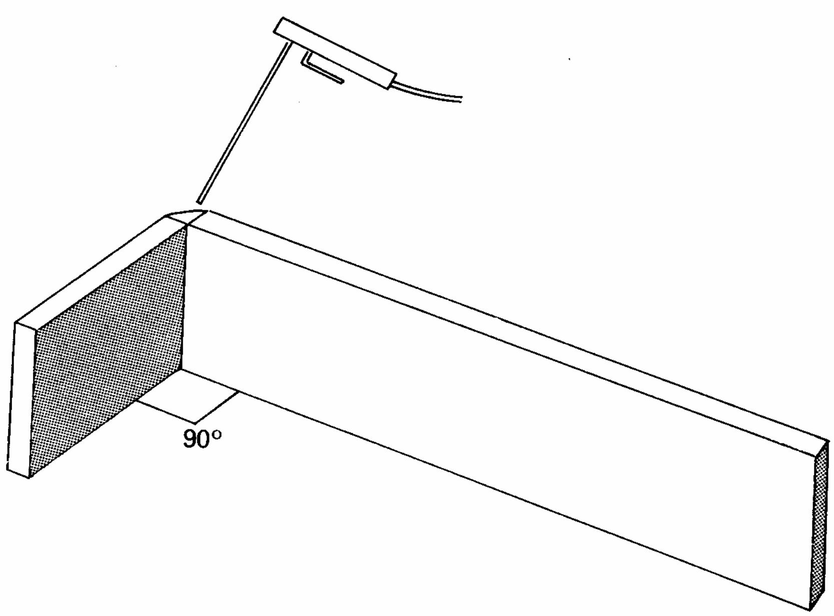


Figure 56. Weld E14 and E15 together



Mark out the two clamps E16 (Figure 57). Drill, saw and file the slot as before. Clamp on M10 nut over the 12mm hole (Figure 58), using a bolt screwed through from the other side, and weld. Repeat for second clamp. Weld the thumb bar E17 on to an M10 × 30-40mm bolt (Figure 59).

Figure 57. Mark out clamps E16

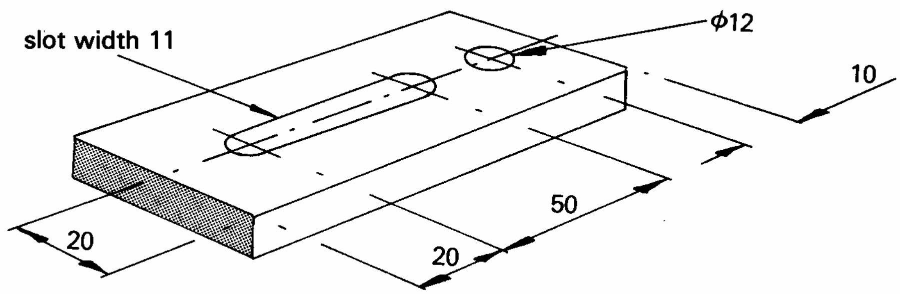


Figure 58. Weld nut to clamp.

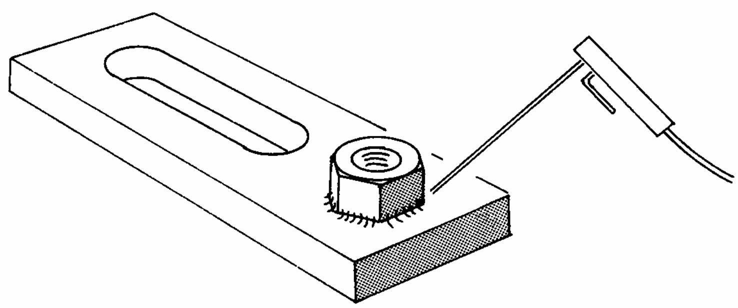
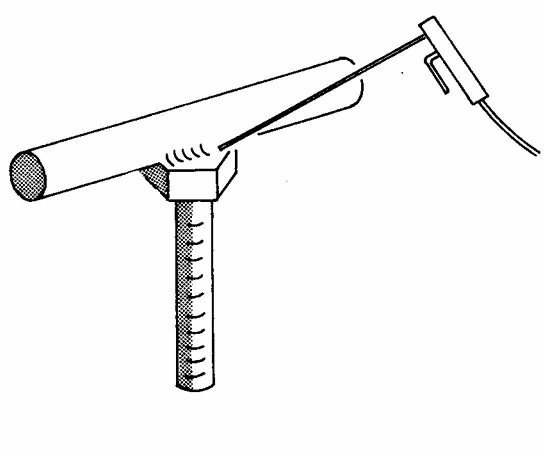


Figure 59. Weld thumb bar E17 to M10 bolt



Assembly

Fasten the three oil-soaked wood bearings to their respective bracket assemblies using M6 × 30mm bolts with washers under the bolt heads and nuts.

Working with the pillar flat on the ground, postition the bearing bracket approximately (the upper bearing on top of the upper cantilevers, the middle bearing on top of the lower cantilevers, and the lower bearing at the foot of pillar) and slide the drive-shaft through them from the top. Slide the crank onto the drive-shaft. Screw one M8 nut onto each of two M8 × 20mm bolts and screw one bolt into each of the nuts welded to the crank. Turn the crank so that the bolts 'pinch' the flats on the drive-shaft, then tighten the lock-nut. Now clamp the brackets approximately in place. Centre them so that when viewed from the top the drive-shaft is in the centre of the pillar, and $x = x$ (see Figure 60).

Figure 60.

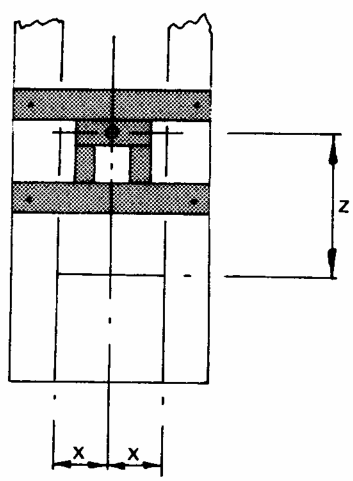
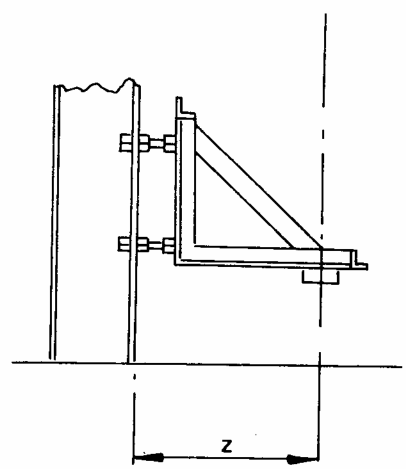


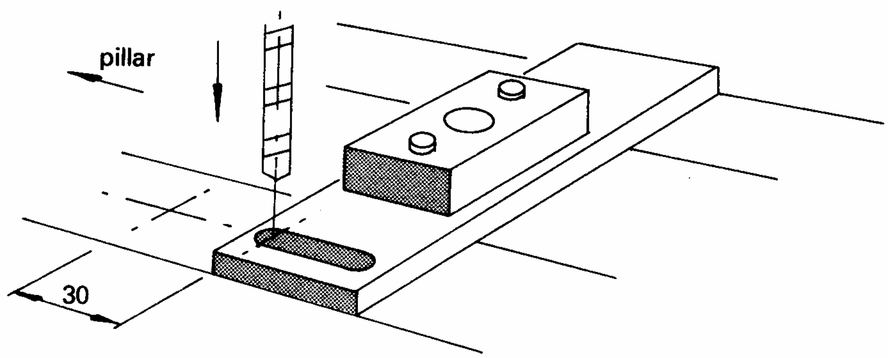
Figure 61.



The bottom bearing bracket should clear the crank by approximately 5mm. Centre the bracket and drill the pillar, through the holes in the bracket, 6mm. Remove the bracket, push one M6 × 30mm bolt through from the inside and screw on a nut, tight, on all four holes. Put another nut on each bolt, finger tight. Then place the bracket on the bolts, and then put another nut on each bolt. By adjusting the nuts either side of the bracket, misalignment of the shaft to the bracket can be accommodated.

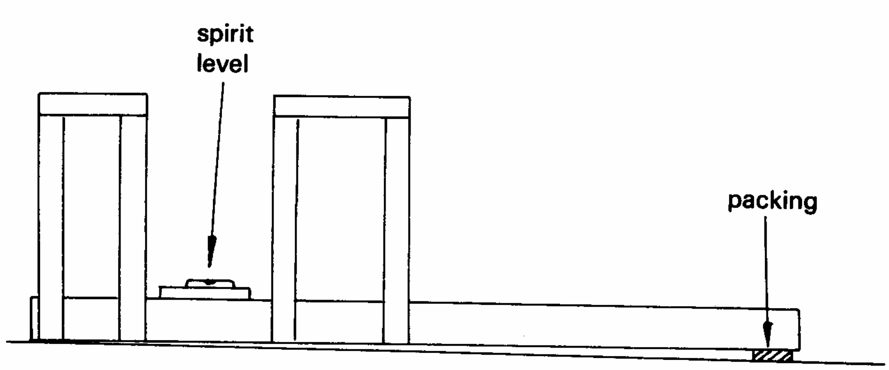
Adjust the bearings to give maximum distance from the pillar z, (Figure 61). Now line up the bearing brackets so that the drive-shaft to pillar distance z is the same at the top and bottom, e.g. $z = z$ (see Figure 60). Re-check that $x = x$, clamp and drill the frame, through the top bracket, 3mm then 6mm, bolt in place and remove the clamps. Centralize the middle bracket and clamp, and check that the drive-shaft turns satisfactorily. Now drill 6mm at the pillar end of both slots, (Figure 62) and bolt in place. Now mark, centre punch and drill another pair of 6mm holes 30mm closer to the pillar, but on the same centre distances (Figure 62).

Figure 62. Drill frame for middle bracket



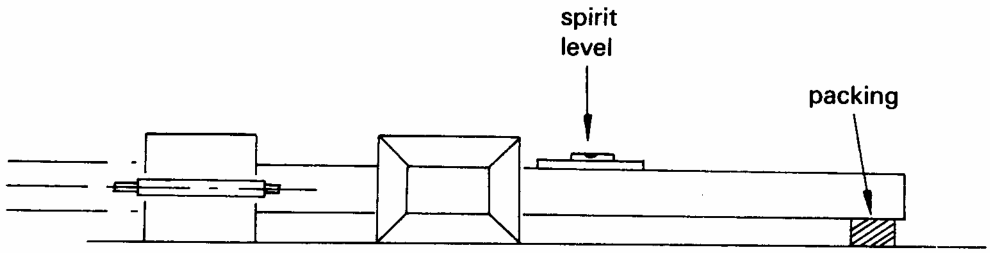
Bolt bearings D3 to seats D4 and slide them onto the spindle, and approximately position them in the frame. Also slide the pulleys onto their shafts. Clamp up the spindle so that with the drive-shaft at maximum distance from the pillar, the belts (13 × 11mm A section V-belts, 950mm pitch length) can just be slipped onto the pulleys. Then using a spirit level on the pillar (Figure 63) pack under one end to get the pillar level. Once level, lie the spirit level on the drill spindle and adjust the spindle (tap with a soft mallet) until it too is level i.e. parallel with the pillar. Check the spindle is centred between the cantilevers.

Figure 63. Use spirit level and packing to level the pillar



Now turn the pillar through 90° (Figure 64). Level the pillar again and level the spindle. Check the belt tension will be all right. Clamp tight, return the pillar to the original position, and repeat all checks. When satisfied, drill through pilot holes in bearing seats, to 3mm then 6mm, and bolt in place.

Figure 64. Turn pillar through 90°, and level



Slide the bearings onto the table tube (Figure 65), and position in the frame approximately, so that the spindle centre is in line with the table centre. Then clamp lightly. Use the same procedure as for the drill spindle, with the spirit level on the table tube. This will ensure that the axis of the spindle and the table are parallel, ensuring 'trueness' of all holes drilled. When satisfied with the alignment, drill a 3mm diameter hole through the top bracket. Mark and centre punch the point, on the underside of the frame, that will bring the drill out 20mm from the short edge and 15mm from the long edge of the lower bracket. Then drill these four corner holes to 3mm diameter. Remove the table assembly, but replace the bearing brackets and drill all eight holes 6mm.

Figure 65. Slide bearing on to table

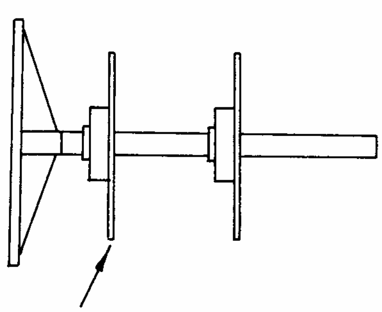
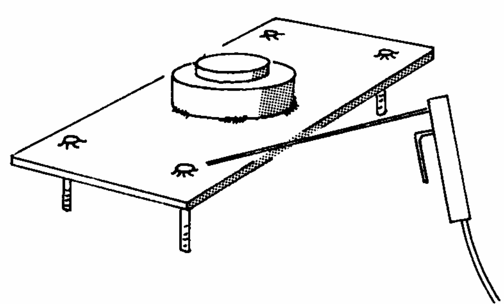


Figure 66. Weld bolt heads



Push M6 × 30 bolts through the bearing plates (Figure 66), and weld the bolt heads. Screw a nut up to the plate on each bolt and replace the bearings on the table tube in the same order. Replace the assembly in the frame (Figure 67). Screw another nut on to each bolt.

With this arrangement it is possible to adjust the seats to counteract the twists in the frame. With the bottom seat nuts finger tight, adjust the top nuts to achieve the easiest slide of the table. Then adjust the bottom nuts in the same way.

Figure 67. Set in frame

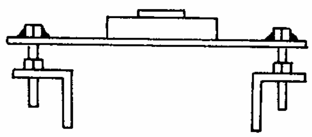
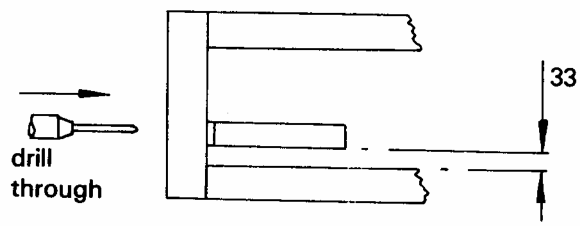


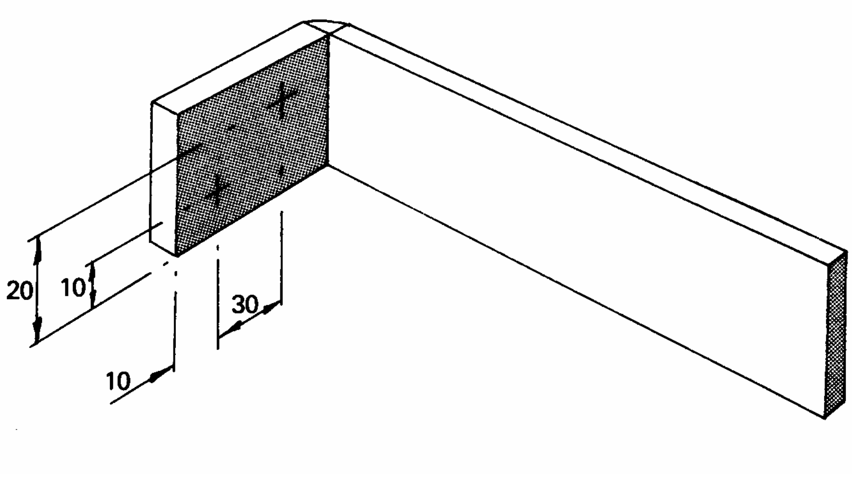
Figure 68. Fit bracket E14/15



Pass one M8 bolt through the handle pivots E12, sandwiching the handle E7. Line up the handle pivots in the front of the lower cantilevers, so that the forks go around the table tube, and then clamp pivots to the frame. Check the handle movement. The forks should move from top to bottom without touching the tube. Drill through 6mm diameter, and bolt in place.

Position the bracket E14/15 so that the bottom edge is 33mm above the lower cantilever (Figure 68). The inside edges of both cantilevers and the bracket should be in line; check this with a ruler. Clamp the bracket in place and drill through 3mm (Figure 68) from the front of the cantilever, so that the two holes are spaced approximately as in Figure 69. Drill the 3mm holes to 6mm and bolt in place.

Figure 69. Spacing of holes in bracket E14/15



Clamp the two pin guides E13 (Figure 70) so that there is a 10mm gap between them, and so that the centre line of the table is midway between them.

Assemble the handle extension and the handle, using an M8 bolt. Now insert 10mm diameter pin through one of the holes in the table tube and between the guides. Move the table up and down (Figure 71), and check that the table moves vertically but does not rotate about its axis. There should be only a small clearance between the pin and guides. When satisfied with the movement of the table, drill 3mm diameter holes through the frame and guides at the top, and then also through the bracket E14/15 and the guides at the bottom. Then drill the holes to 6mm and bolt up with M6.

Figure 70. Clamp pin guides

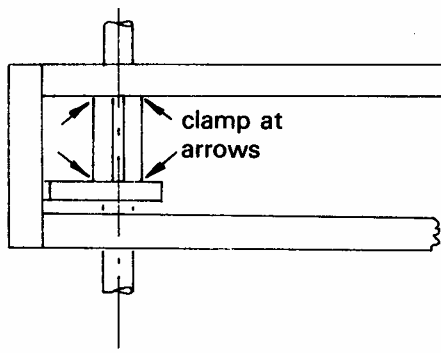
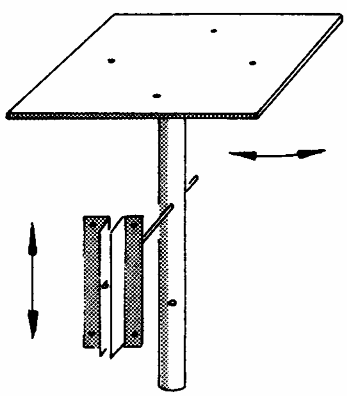


Figure 71. Check vertical movement



Attach con rod to crank. Clamp the foot push assembly to the pillar so that the con rod sits just under the foot push. Set up the foot push as in Figure 72, mark the position *x* on the foot-push, and drill 3mm diameter and then 8mm holes. Pass through an M8 bolt and make sure that there is a washer between the crank to con rod and the con rod to foot-push, joints (Figure 73). Hand tighten the nuts and check the action of the foot-push. The foot-push should move freely and should stay parallel to the ground. If the foot-push support is clamped on at an angle to the pillar it will *not* move parallel to the ground. When it is aligned properly, tack the supports to the pillar, remove the clamps, and weld. Tighten the nuts on the crank and con rod, then release them to give a little looseness or 'play', then put a lock-nut on each bolt and tighten them, but retain the 'play'.

Figure 72.

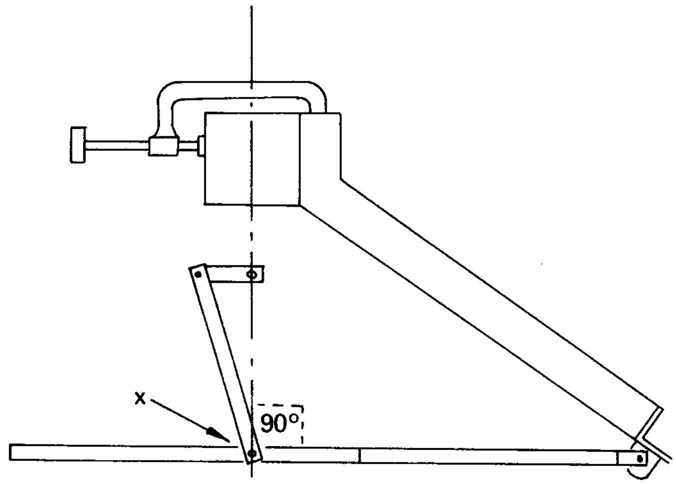
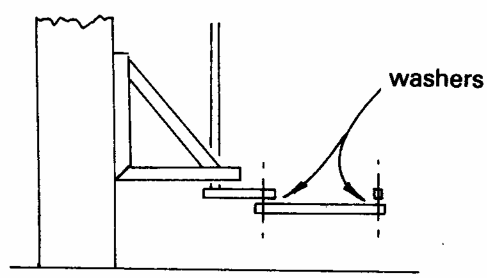


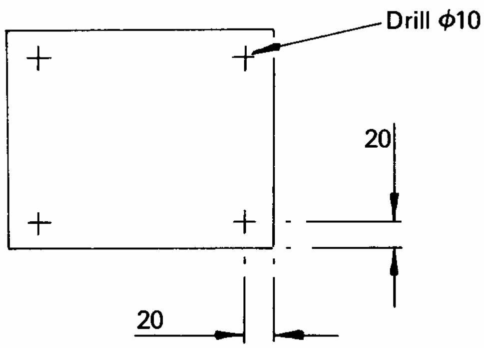
Figure 73.



There are two ways the machine can be installed, either by embedding some bolts in concrete, or by using expansion bolts. Or, if the pillar was left some 600mm longer it could be embedded in the firm ground.

Bolting down requires a substantial (10mm) plate of approximately 300mm × 300mm, with four holes drilled as shown Figure 74. Weld the pillar onto the base checking that it is square, (Figure 75). This weld needs to be strong. If the drill is going to be positioned next to a wall the pillar should be welded towards one side of the plate (Figure 75).

Figure 74. Base-plate hole positions



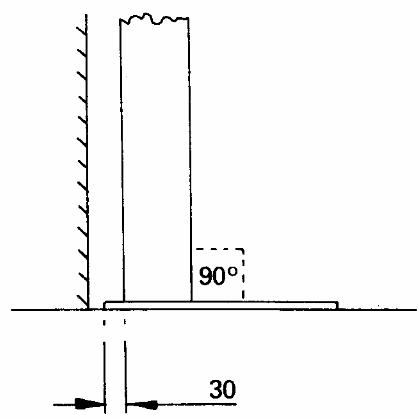
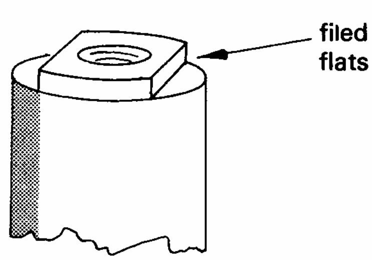


Figure 75. Pillar against the wall

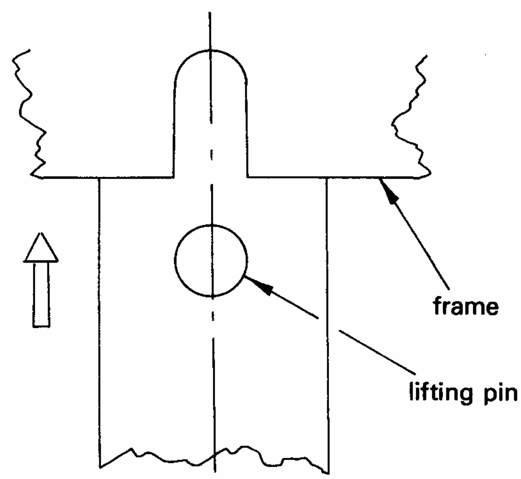
Once the drill is bolted down, a flywheel needs to be fitted. The flywheel can be any round object, which can be bolted on to the top of the drill spindle by the M10 thread. The flywheel must be symmetrical, because as it rotates any imbalance will be exaggerated, causing severe vibration and rocking. The mass of the flywheel should be about 5-10kg. If the flywheel has a large radius (such as a car wheel tyre) it may be necessary to fit a sheet metal guard to prevent head injuries. Heavier flywheels will need to be fixed more securely. A plate should be filed to match the top of the spindle and then welded to the centre of the flywheel (Figure 76). Once bolted on, the plate will lock onto the filed 'flats'.

Figure 76. Filed flats on spindle, to locate heavier flywheel



The foot-steady should be drilled and bolted (M6) to the foot-push where the operator finds it most comfortable to use. The table tube has three holes. The lower two are for the lifting pin. The middle hole is for work which requires a large drill-to-table distance, such as repair work on a bulky object. The lower hole is for most manufacturing work (a distance from the drill tip to the table of approximately 90mm). A 10mm diameter pin is inserted into the top hole when using the table in its higher position. The pin acts as a stop, making it easier to swap the position of the lifting pin. A small slot in the frame will make it easier to withdraw the lifting pin when moving from the middle to lower holes (Figure 77).

Figure 77. Slot in frame to clear lifting pin

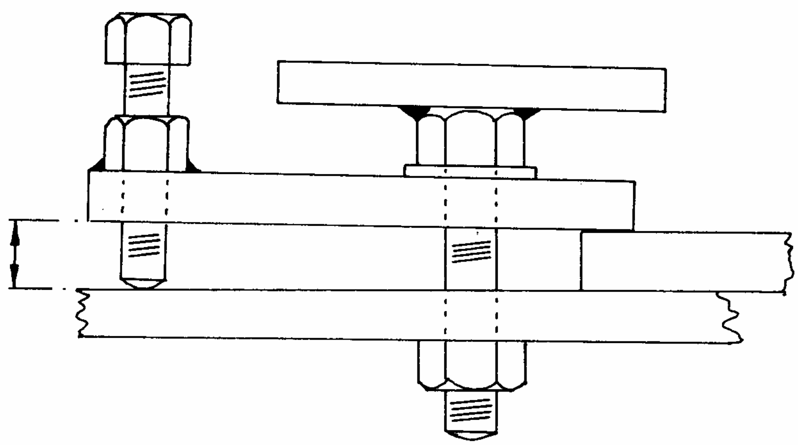


Operation and Maintenance

Once the machine has been built the operation itself is self-explanatory, but it must be remembered that it is possible to operate the machine in reverse, so it is best to give the flywheel a push in the correct direction to start it off.

The clamps are designed to hold the work firmly to the table without the use of a spanner, and are adjustable according to the length of the bolts used, see Figure 78. The adjuster bolt should be set to make dimension *x* slightly bigger than the thickness of the material being clamped. Also, the nearer the clamping bolt is to the work the bigger the clamping effect will be.

Figure 78. Clamps



The handle is designed to fold up when the machine is not in use, to reduce the risk of injury from walking into it and to reduce the space occupied by the machine.

The 6mm diameter hole is for locking the handle, whilst in use, with an M6 bolt.

Cast-iron taper-lock pulleys have been specified, but these may be undesirable, either because of high cost or because of availability. So replacement with light alloy versions may be desirable. Two suggestions for locating these on their shafts are shown in Figures 79 and 80. It may even be possible to manufacture the pulleys if the machinery and expertise are available and the costs low enough.

Figure 79. Grub screw acting on front of shaft

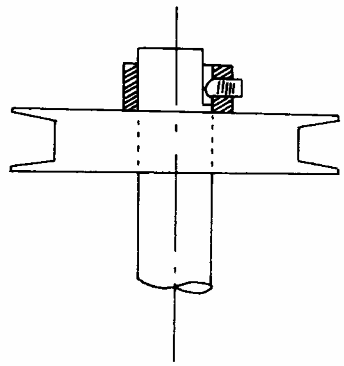
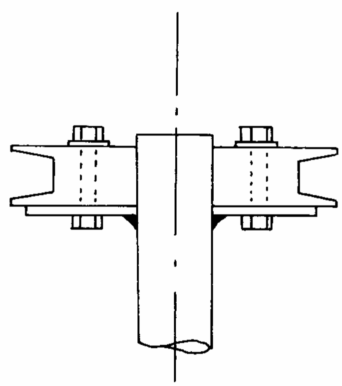


Figure 80. Pulley bolted to a plate welded onto the shaft



The connecting rod could be replaced by a piece of wood treated as for wood bearings. This would make the operation of the foot-push quieter and reduce wear on the bolts at either end.

As the vee belt stretches with wear, the drive-shaft must be adjusted to keep the tension in the belt. Release the M6 nuts on all three wood bearings and move the drive-shaft towards the pillar. Tighten the nuts and check that the drive-shaft is the same distance from the pillar top and bottom. **Note**: excess belt tension increases the effort needed to operate the foot-push.

When the driveshaft wood bearings wear they can easily be replaced. The new bearings can be made by using the machine to drill all the necessary holes, before soaking the wood in oil.

It is a good idea to grease the spindle bearings, now and then, although this need not be done often due to the low loads and speeds being used.