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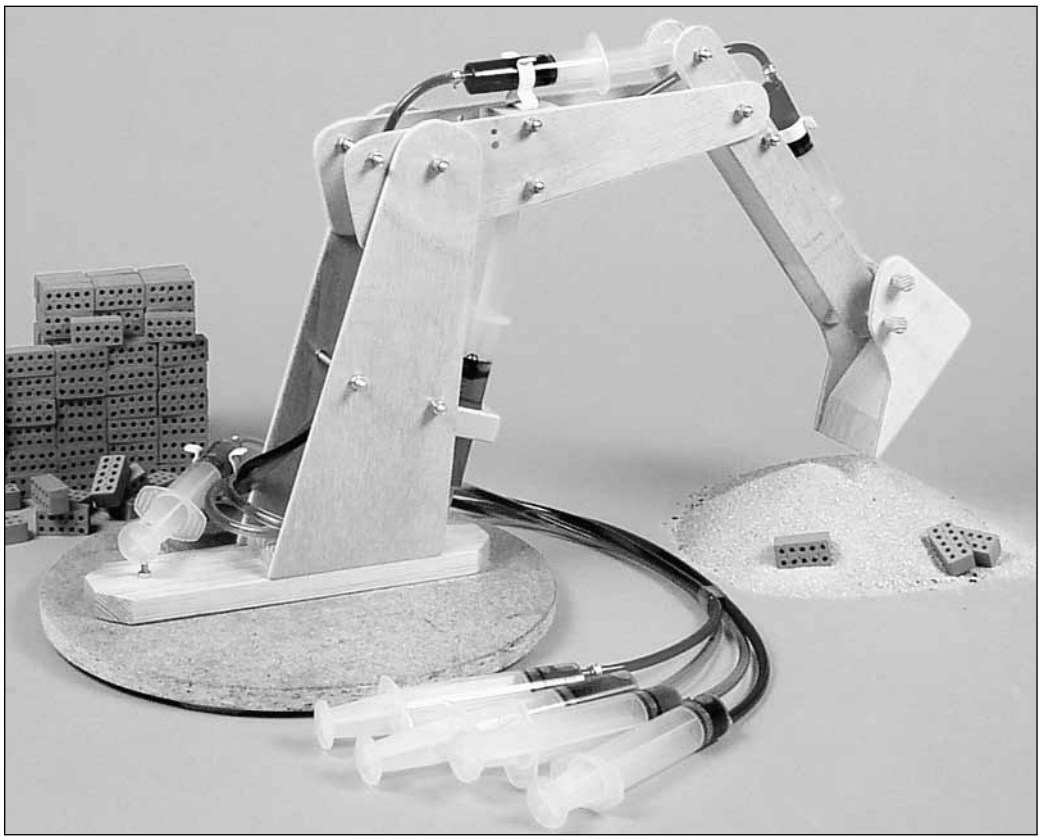
P n e u m a t i c
R o b o t a r m / D i g g e r



Please Note

The OPITEC range of projects is not primarily intended as toys for young children. It is for teaching, designing and making to ensure that pupils experience a range of tools and processes.

1. Product Information:

Article: Pneumatic/hydraulic model in project pack format.

Use: In Design Technology, Key stage 3/4

2. Material Information:

2.1 Material: Pine (Coniferous) softwood.
Wood should be relatively dry before working.
Plywood, is multi-layered with each set in a different direction.
Chip board (made from pressed and glued wood chips)

Working: Wood can be sawn, planed, shaped, filed, drilled and sanded.
Mark out with measurements form the plan or use paperpatterns.

Joining: Screws or white PVA wood glue.

Finish: Wax (liquid or solid)
Wood varnish (Base coat and top coat)
Staining (Colour- water soluable- then clear varnish)
Linseed oil.

2.2 Material: PVC tube (Polyvinylchoride - Thermoplastic)
Transparent, elastic.

Joining: Interlocking

Finish: No special finish necessary

2.3 Material: Syringe (PP=Polypropolene = Thermoplastic)
Transparent, elastic

Joining: Interlocking, clamping

Finish: No special finish necessary

3. Tools:

Sawing: Use a **Fret saw** for curves and round shpes that cannot be sawn with other saws.

Note ! Fret saw blades should be inserted with the blade teeth facing forward!

Use a special Fret saw board and work with slowconstant strokes turning the work as you go.

Use a **Dovetail saw** or similar for all straight cuts and wood strip.

Note ! Use a bench hook to hold the work whilst sawing!

A **Puk type saw** (see Opitec Cat. page 229) is ideal for cutting small pieces of work and dowel.

Rasps/Files: Use the correct grade of rasp or wood file for the work in hand.

Note ! Rasps and files only cut on the forward stroke!

Sanding: Use a block and glasspaper on flat surfaces and loose sheet on curves and individual shapes.

Drilling: Use a hand drill or a pillar drill.

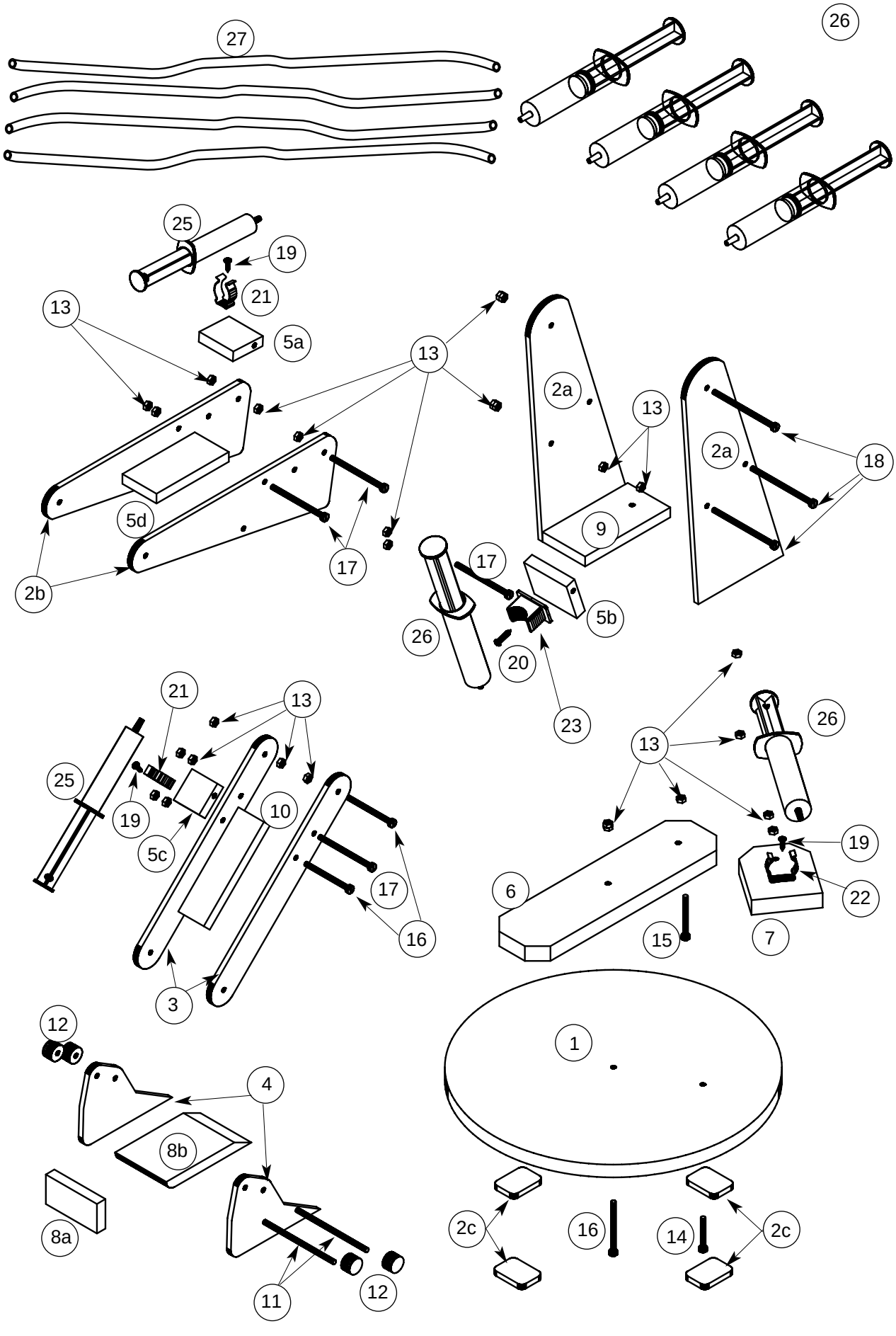
Note ! Adhere to the safety rules when drilling. (Tie all long hair back, wear safetyglasses and an spron, remove rings and jewellery. Hold the work to be drilled in a machine vice)

Clamping: Hold glued work securely with G Clamps whilst it is drying. (Do not over tighten them or they will leave marks)

4. Parts List:

Part	Material	Quantity	Size	Diagram
Base	Chipboard	1	13 x 280 x 280 mm	1
Base carrier/ 1. Arm	Plywood	3	5 x 100 x 250 mm	2
2. Arm	Plywood	1	5 x 70 x 250 mm	3
Shovel	Plywood	1	5 x 110 x 110 mm	4
Syringe fixing	Plywood	1	10 x 40 x 200 mm	5
Fixings	Pine	1	15 x 60 x 225 mm	6
Syringe fixing	Pine	1	15 x 60 x 75 mm	7
Shovel	Pine	1	10 x 60 x 150 mm	8
Cross members	Pine	1	10 x 50 x 150 mm	9
Cross members	Pine	1	10 x 30 x 100 mm	10
Mechanical Parts	Beech dowel	1	4 dia x 250 mm	11
	Beech pine	4	15 dia x 10 mm	12
	Nuts	30	M4	13
	Machine screw	1	M4 x 30 mm	14
	Machine screw	1	M4 x 40 mm	15
	Machine screw	3	M4 x 50 mm	16
	Machine screw	4	M4 x 60 mm	17
	Machine screw	3	M4 x 70 mm	18
	Chipboard screws	3	3 x 10 mm	19
	Roundhead screw	1	4 x 16 mm	20
	Spring steel dip	2	14-17 mm	21
	Spring steel dip	1	17-22 mm	22
	Fixings	1	17-22 mm	23
	Silver wire	1	dia 1 /2000 mm	24
	Syringes	2	10 ml	25
	Syringes	6	20 ml	26
	PVC-tube	1	6 dia/4000mm	27

5. Exploded diagram



6. Planning overview

6.1 Planning and making the base.

6.2 Planning and making the carrier blocks for the spring clips.

6.3 Planning and making the base arm.

6.4 Making and assembling the lower arm 1.

6.5 Making and assembling the jibarm 2.

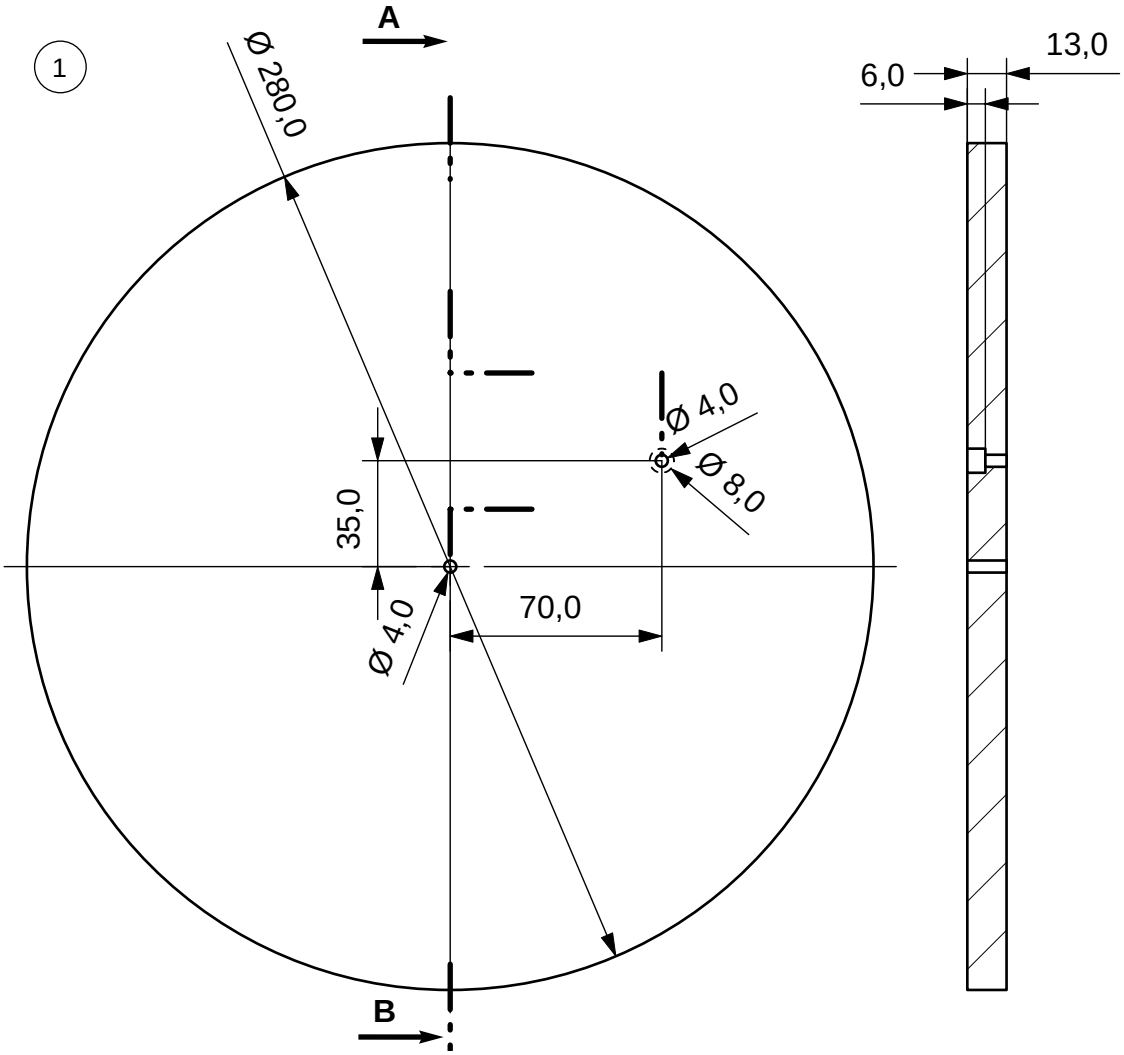
6.6 Planning and assembling the bucket.

6.7 Planning and assembling the pneumatics/hydraulics.

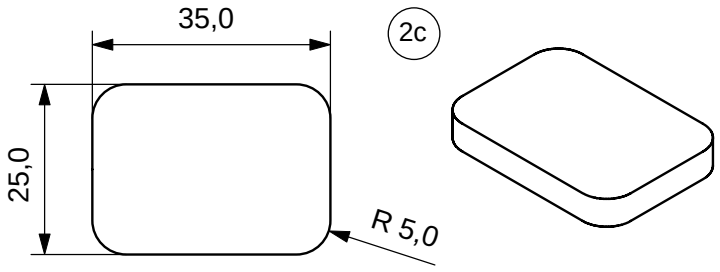
6.1 Planning and making the base.

6.1.1 Mark out the circle on the base (1) 13x280x280mm drill the centre hole 4 mm and counter bore the 8mm dia. (blind) hole and saw out the circle shape. Use a sander to finish.

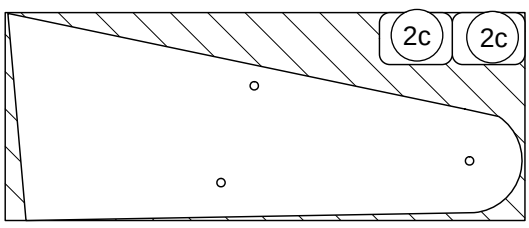
Note: The design of the base is not so important, you can simply leave it as a square if you wish!! Drill the 8mm x 6mm deep dia. counter hole from the underneath.



6.1.2 Mark out and saw out the four feet (2c) fromthe plywood sheet (2). Clean up and round edges with sandpaper.

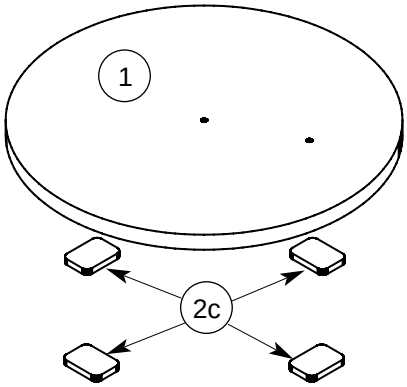


Cutting plan



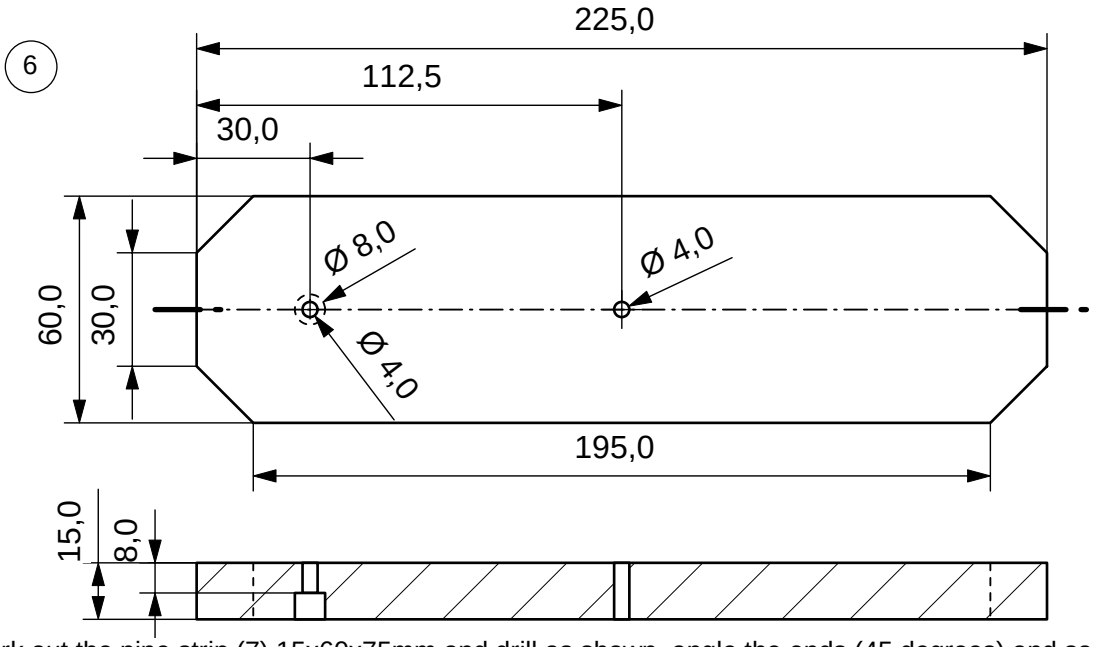
6.1.3 Arrange and glue the four feet (2c) under the base (1) as shown in the diagram.

Note: The counter bored blind hole is underneath!

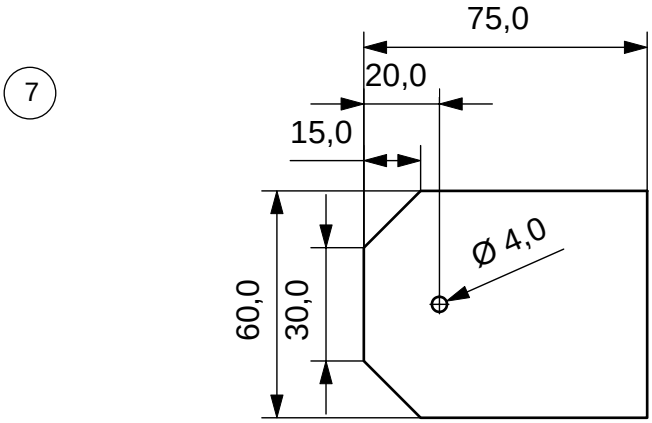


6.2 Planning and making the carrier blocks for the spring clips.

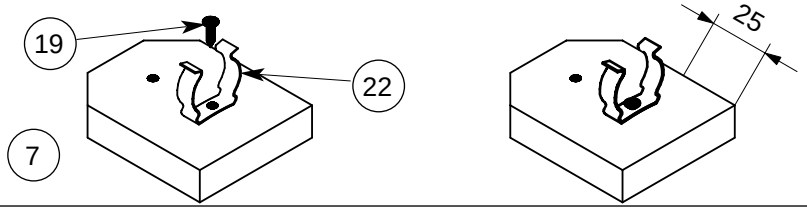
6.2.1 Mark out the shape on the pine (6) 15x60x225mm drill including the blind hole, saw the ends (45 degrees) and sand smooth.



6.2.2 Mark out the pine strip (7) 15x60x75mm and drill as shown, angle the ends (45 degrees) and sand smooth.



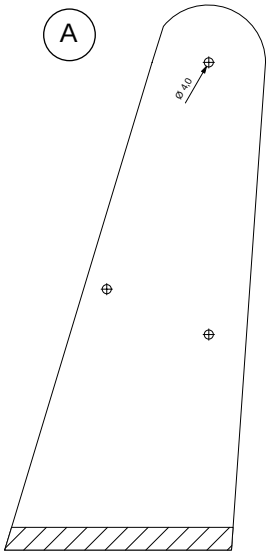
6.2.3 Mount the spring clips (22) on the carrier (7) as shown, using the chipboard screws (19).



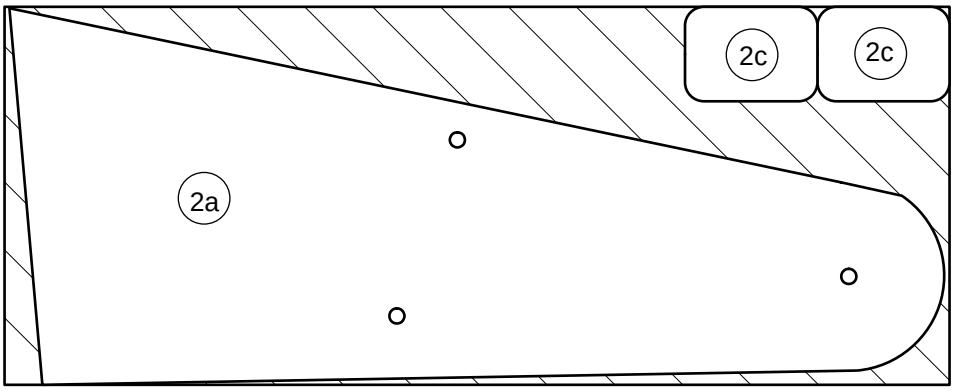
6.3 Planning and making the base mounted arm.

6.3.1 Transfer the patterns A (see page 17) on to the two plywood sheets (2) 5x100x250mm drill, saw out and sand smooth.

Note: The plywood sheet 2 has already been used for the feet. When making the arms it better if both parts can be drilled and the sawn at the same time by laying the two sheets of plywood on top of each other.

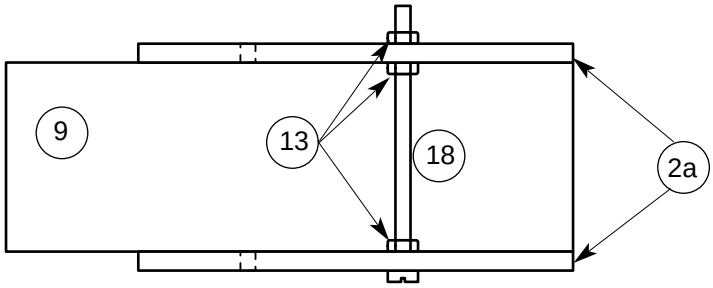


Cutting plan

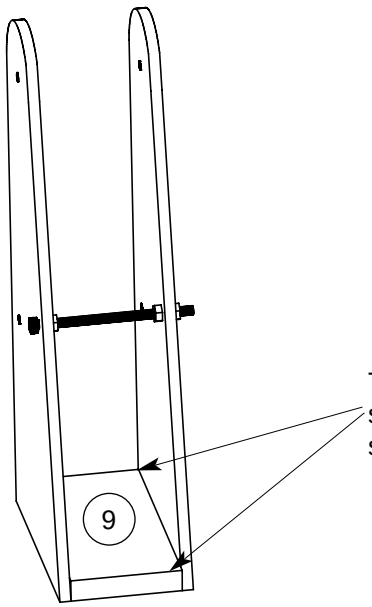


6.3.2 Glue the spacer (9) 10x50x150mm in position (2a broken line on pattern on page 17). At the same time ensure that all the holes in the arms line up parallel with each other. Hold the parts together using the machine screw (18) and 3 nuts (13) as a distance adjuster, as shown in the diagram.

Note: By using the machine screw (18) and (13) nut adjuster shown in the plan an exact distance (50mm) between the arms can be set. The nuts are tightened in this position to stabilise the design.

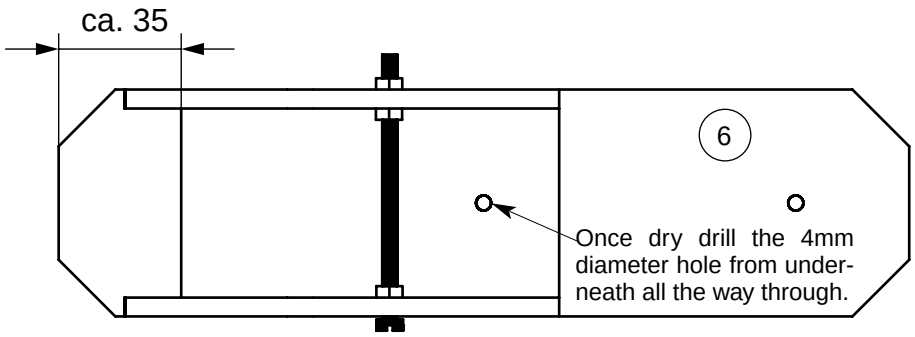


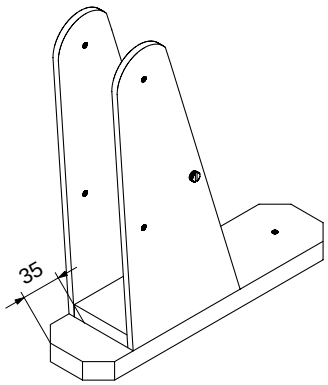
6.3.3 Once the glue has dried the pine strip (9) can be trimmed and the angled contours of the arm sides carried on to this base strip (9).



Trim the length of the pine strip (9) to fit the angle of the side arms!

6.3.4 Glue the base arms on the holder (6) in position 35 mm in from one end.



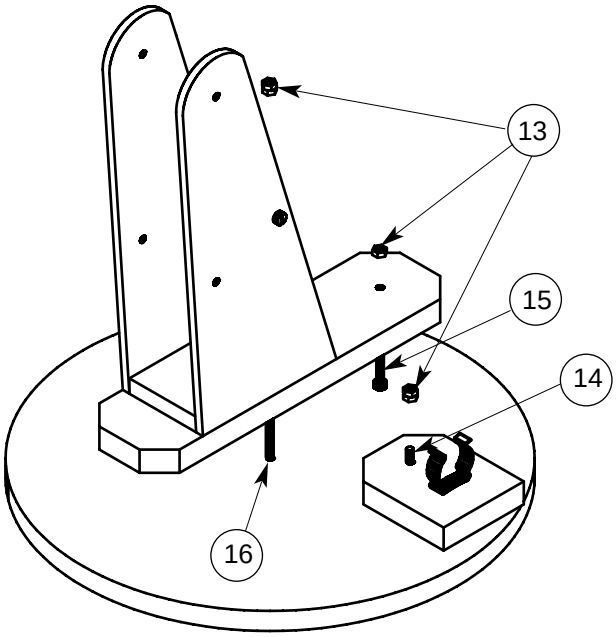


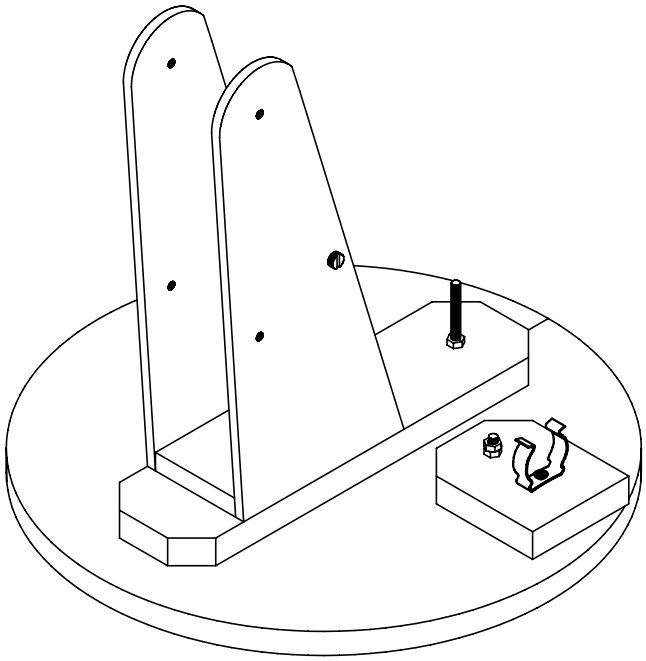
6.3.5 Once dry drill a 4 mm hole in the holder (6) from underneath.

6.3.6 Insert a machine screw (15) M4x40mm from underneath through holder, part (6) and fix with 2 counter tightened lock nuts (13) so it can turn.

Note: Tighten the nuts!

Finally, now line up the carrier, with spring clip, on the circular base so that a machine screw (16) M4x50mm can be inserted as the turning pivot and lock it in position with two nuts (13) the carrier should be able to turn easily.



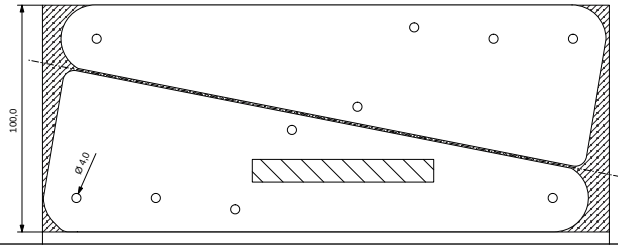


6.3.7 Fit the carrier (7) complete with spring clip to the base to the base and hold it in position with the machine screw (16) M4x50mm and fix it with 2 contra tightened nuts (13). The carrier must be able to turn easily.

6.4 Making and assembling the lower arm 1

6.4.1 Trace the pattern B (see page 19) on to the third sheet of plywood (2) drill the holes, saw out the shapes and sand smooth.

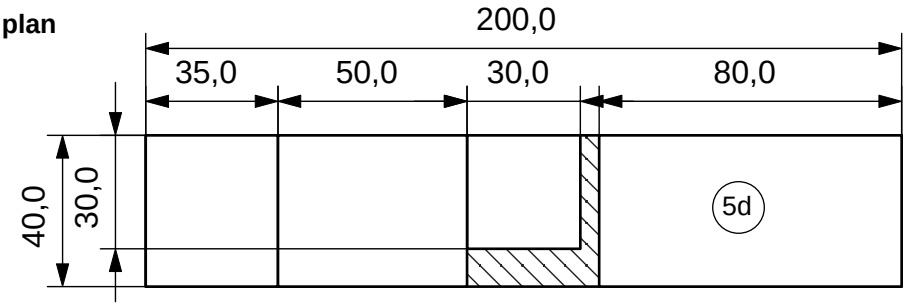
Tip: Saw the plywood sheet (2) through diagonally first and then work on both of the sides in one go, so that they are exactly the same.

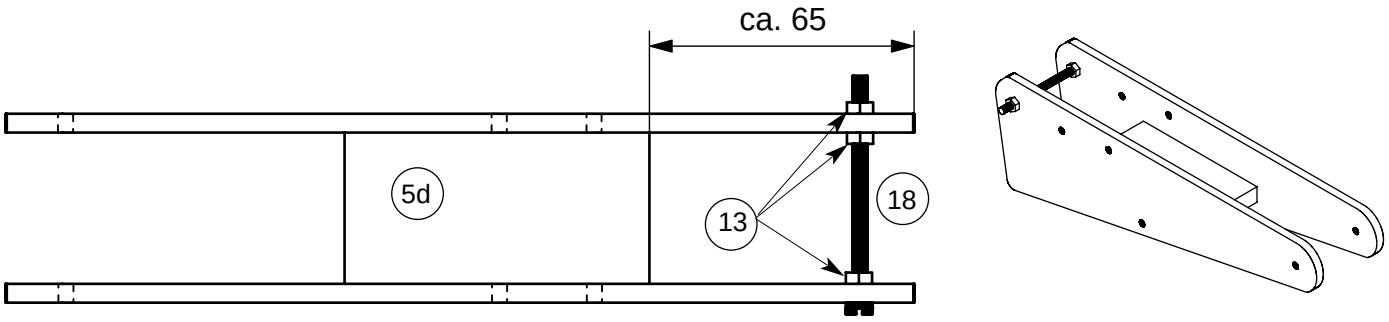


6.4.2 Mark and saw out the spacer (5d) from the plywood sheet (5) 10 x 40 x 85 mm and glue it between the two arms making sure that the holes drilled in both the arms line up with each other. Use a machine screw (18) an d 3 x M4 nuts (13) to also act as a spacer adjustment as shown.

Note: Using the machine screw (18) and the nuts (13) an exact distance of 50mm between the sides of the arms can be set.

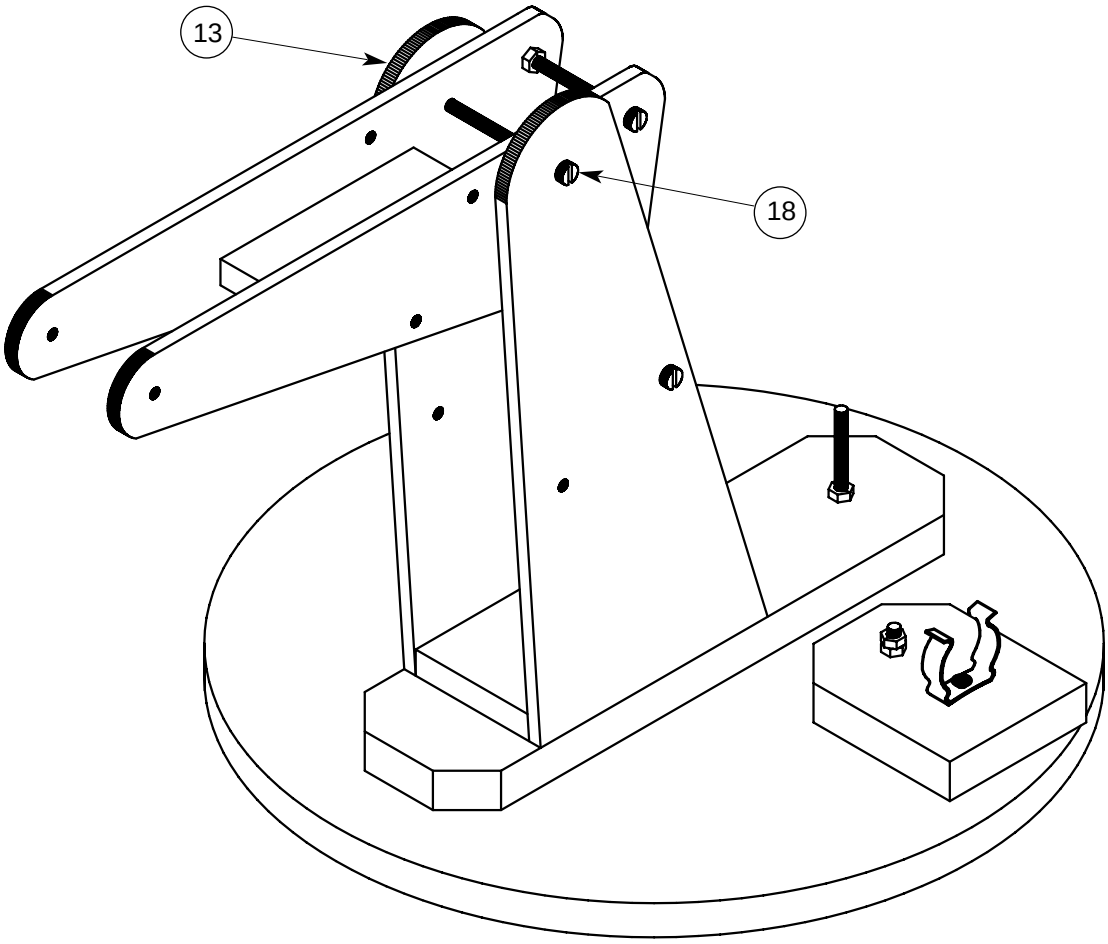
Cutting plan





6.4.3 Once the completed arm 1 is dry it can be placed between the base arm, the machine screw (18) can be inserted and tightened with lock nuts (13) so that it moves easily up and down without too much play.

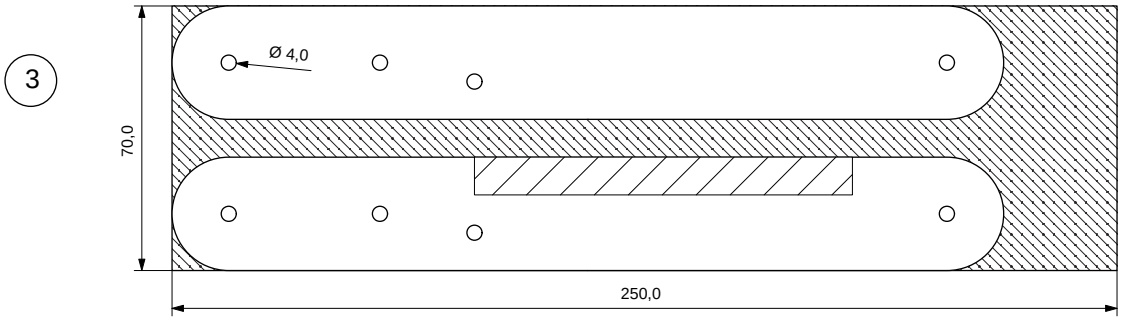
Note: Due to the fitting tolerance, the gap between the sides of the base arm and lower robot arm may be too small causing it to 'stick'. This problem can be solved by adjusting the distance spacer nut s (13) on the base arm and set screw, (18) so that the gap between sides is made larger, freeing the arm, allowing it to move easily.



6.5 Making and assembling the Jibarm 2

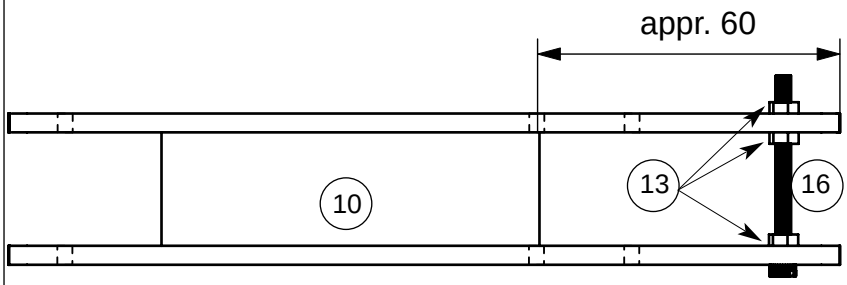
6.5.1 Using pattern C (Page 21) mark out the jib arm 2, on the plywood sheet (3) 5 x 70 x 250mm drill the holes, and saw out the shapes and sand smooth.

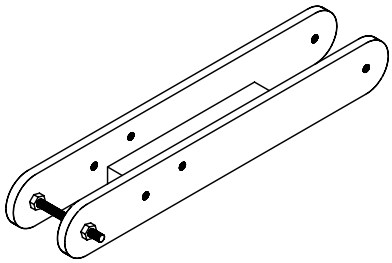
Tip: Place both halves of the jibarm over each other and work on the shapes together. Drill the holes together so that they line up.



6.5.2 Insert the spacer strip (10) 10 x 30 x 100mm (shaded part on plan) between the arms (3) and glue it in position. Insert a machine screw (16) as a spacer and lock it in position with 3 nuts (13) as shown in the diagram.

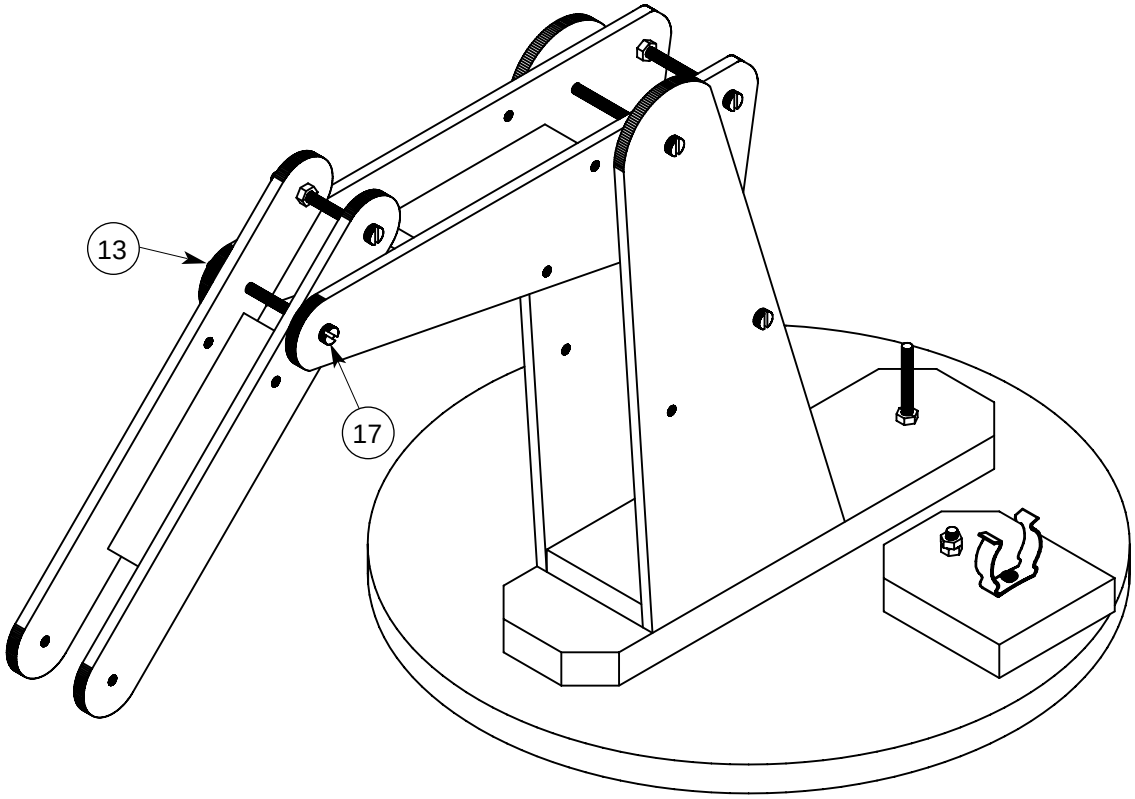
Note: Using the machine screw (16) and the M4 nuts (13) as an adjuster the distance of 30 mm can be exactly set.





6.5.3 The jibarm 2 (once dry) can now be mounted in position using a machine screw (17) and M4 nuts (13) and locked in position so that it can move up and down easily but without too much play.

Note: Due to the fitting tolerance between the arms, (Parts 1 and 2) it is possible that they do not move freely. This problem can be solved by adjusting the distance screw (16) and the nuts (13) on 'Arm 2' inwards, so that the gap between the end of the arm is narrowed.

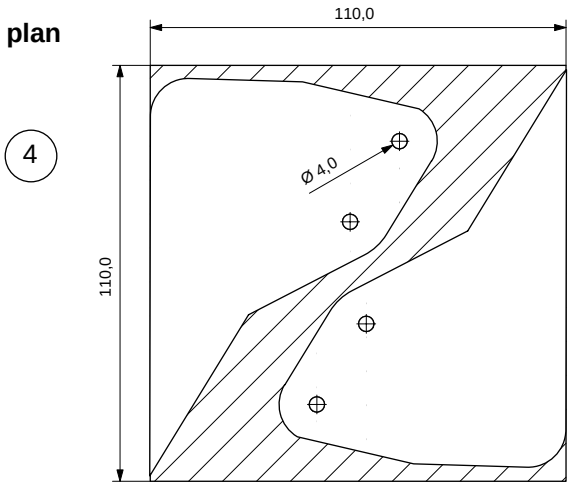


6.6 Making and assembling the bucket

6.6.1 Using the pattern D (page 17) trace the side shapes of the bucket on to the plywood sheet (4) 5x110x100mm, saw them out. Sand them smooth.

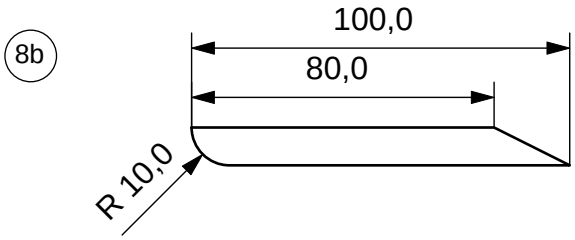
Tip: Firstly saw the plywood sheet through diagonally and then saw out both halves of the bucket in one go. Drill the holes in both halves together.

Cutting plan



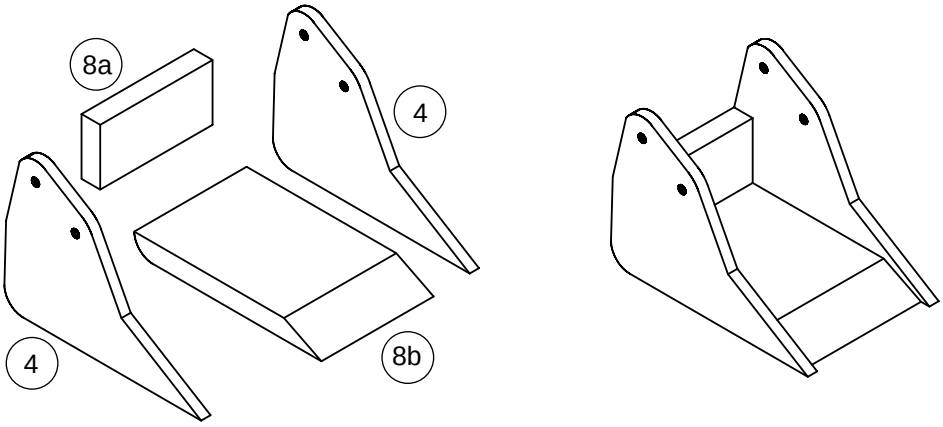
6.6.2 Saw a 30mm (8a) long piece from the pine strip (8) and sand the ends.

6.6.3 Part (8b=remainder) saw out and angle as shown in the diagram.



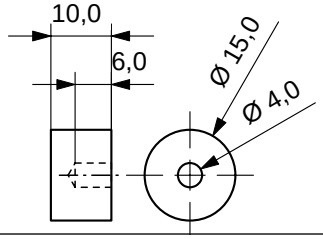
6.6.4 Assemble parts 8a/8b/4 and glue them together to make the bucket.

Note: make sure that the holes line up!



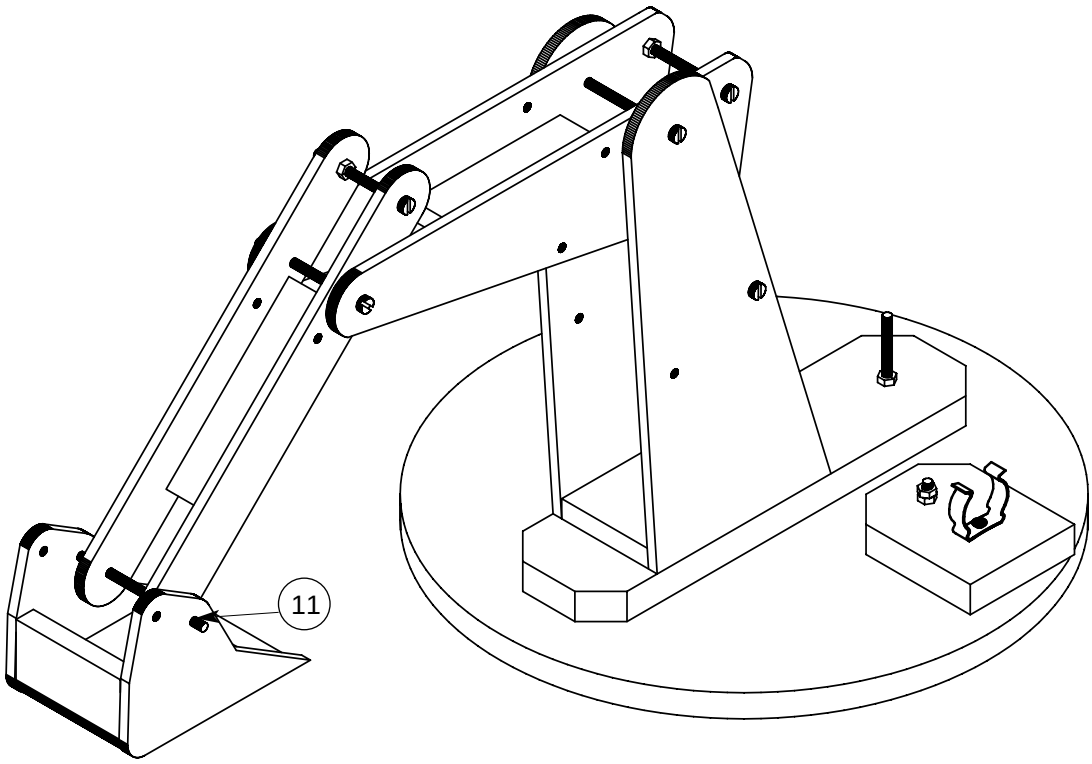
6.6.5 To hold the bucket two pieces of dowel are needed (11) each 85mm long, sawn from the length 4mm dia x 250mm.

6.6.6 Drill a blind hole approx 4mm dia x 6mm deep in the wooden discs (12).



6.6.7 Once the glue has dried fit the bucket on to the jibarm 2 using ghe dowels (11) 4dia x 85mm.

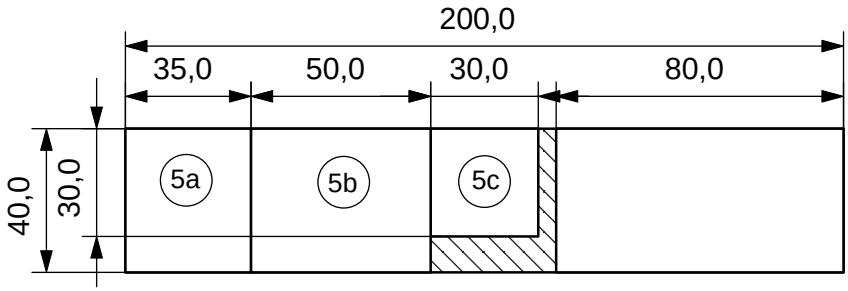
Note: Do not glue them in position at this stage. Later the ends of the dowel will be covered by the wood discs.



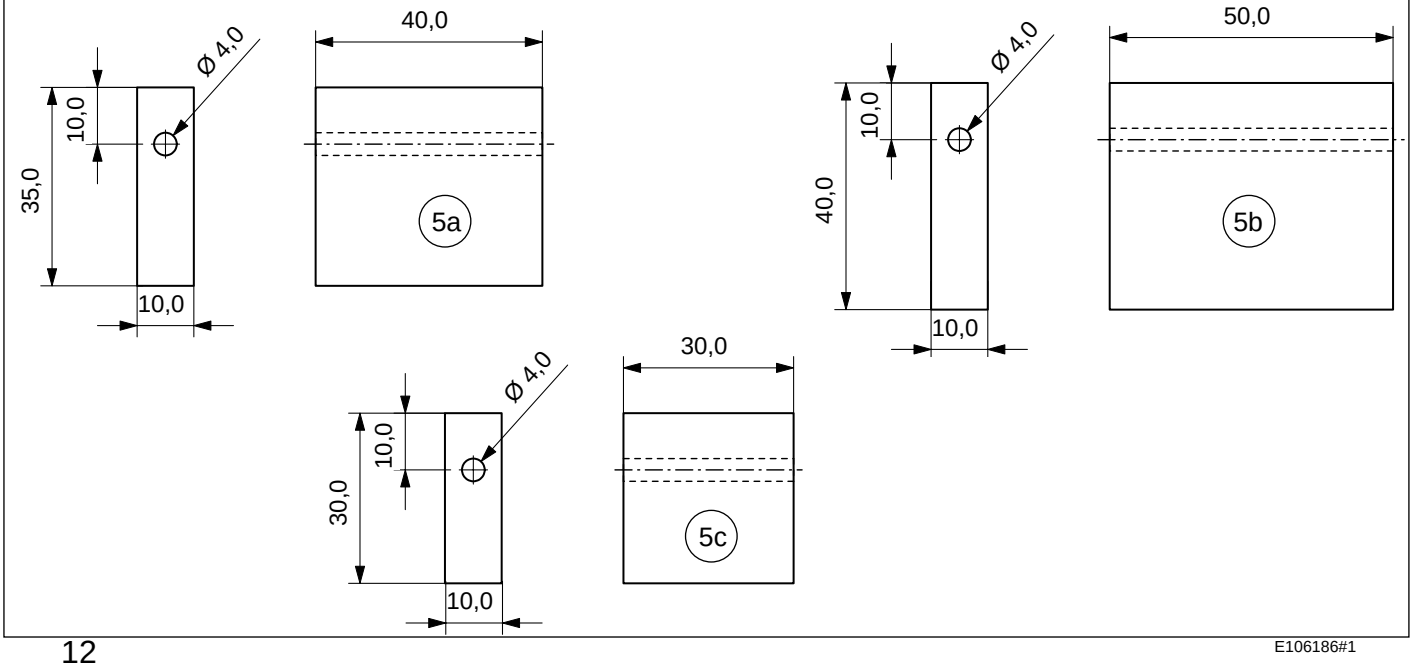
6.7 Making and assembling the pneumatic/hydraulic system

6.7.1 Mark and saw out the syringe carriers on the plywood (5) and sand them smooth.

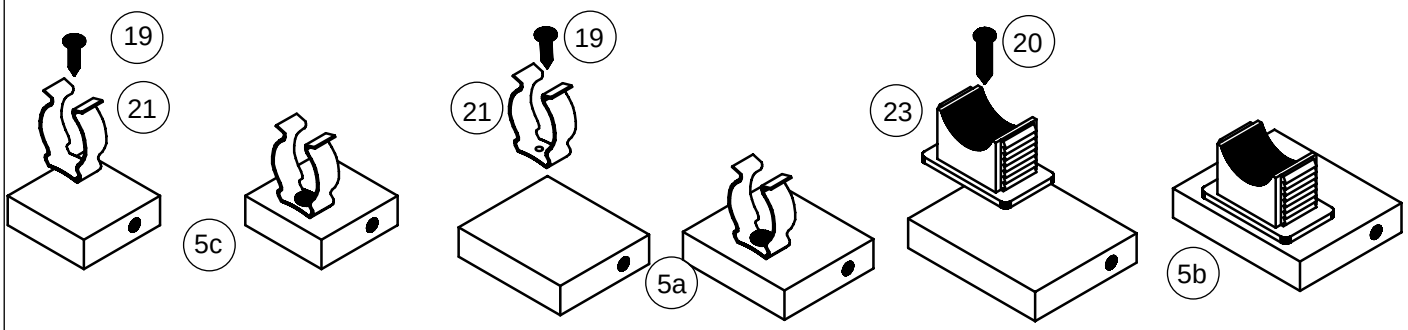
Cutting plan



6.7.2 Place the parts in a machine vice and drill them vertically with a 4mm bit as shown. Holes are indicated by the broken lines.

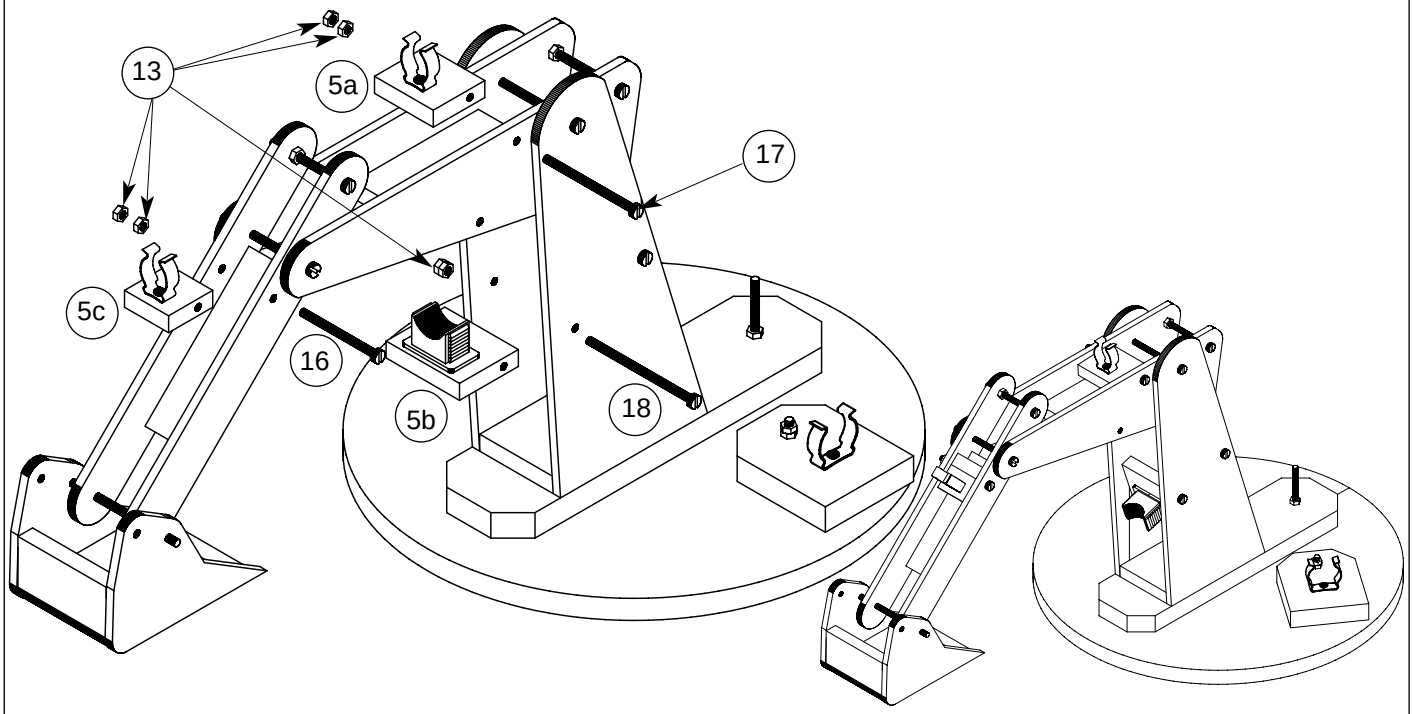


6.7.3 Mount a spring clip (21) with a screw (19) on each syringe carrier (5a / 5c). Mount the PVC tube clips (23) with the screws (20) on parts 5b

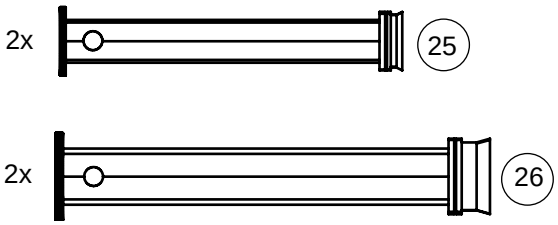


6.7.4 Mount a syringe carrier (5b) and a PVC tube clamp (23) between the base arm so that the hole lines up with the hole for the machine screw (18). Hold it in place with a machine screw (18) and tighten it with nuts so that it can still move.

Mount the syringe carriers(5a) (5c) on robot arms and fix them with machine screws (17) and two nuts (13) as shown in the diagram.



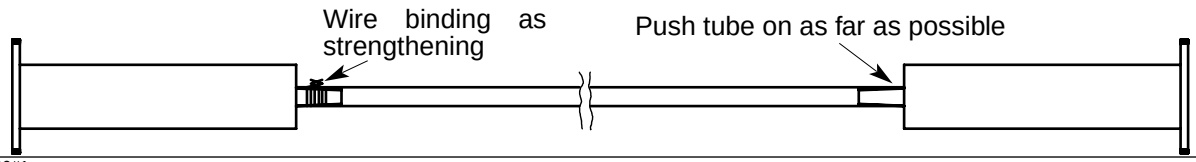
6.7.5 Drill a 4mm diameter hole in each syringe (25/26) piston as shown



6.7.6 Cut the following lengths from the PVC tube (27) , 2 pieces 1000mm (27a) and one piece 800mm (27b) and one piece 1200mm (27 remainder)

6.7.7 Join two of the large syringes together as shown with a length of tube (27b) make sure that the ends are pushed right up tight (24) and bind wire around for extra strength.

Note: A good tip is to apply glue the tube ends to the syringe first (use instant or two part glue) and then secure with wire. Roughen the parts to be glued (glasspaper) first.
Make sure that none of the glue runs into the tube or pistons.



6.7.8 Join together a large syringe (26) and a small syringe (25) with the plastic tube (27c) exactly the same as in step 6.7.7

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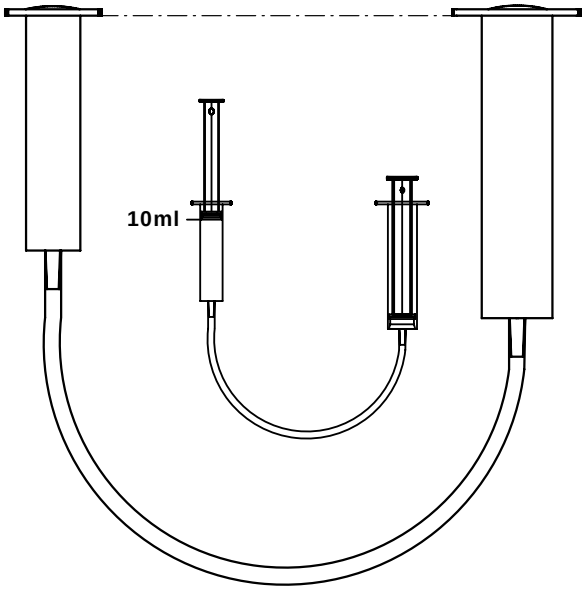
6.7.9 Fill both of the systems with water, making sure that they do not contain any air bubbles.

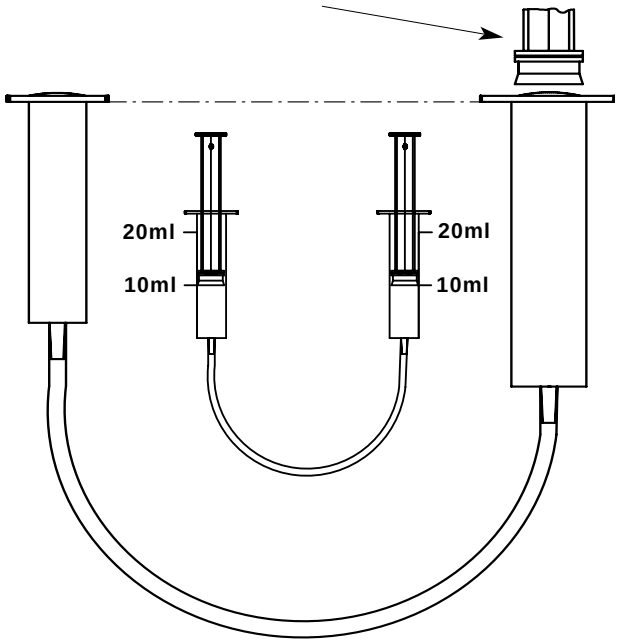
Note: to differentiate between the systems coloured water can be used (food colouring)

Observe: When you press the down on the large syringe plunger/piston the plunger on the smaller syringe should not fall out.

Fill with water until it overflows on the other side!.



Insert the plunger / piston to adjust the exact levels that are needed.!



6.7.10 The system with the syringes (25/26) and tube (27c) is to activate the bucket. The small syringe (25) is threaded through the base arm 1. Fix the plunger of the syringe to the second dowel (11) which acts as a pivot for the bucket..

Note: Do not glue the wooden end discs in place yet.

Fix the syringe cylinder in the spring clip on the carrier (5c)

6.7.11 The system with the syringes (25/26) and the tube (27a) serves to activate the jib arm 2. Firstly release the nuts (13) and screws (16) from arm 2 and pull them out. Thread the small syringe (25) through the base arm mount it on arm 1 and re-screw the fixings.

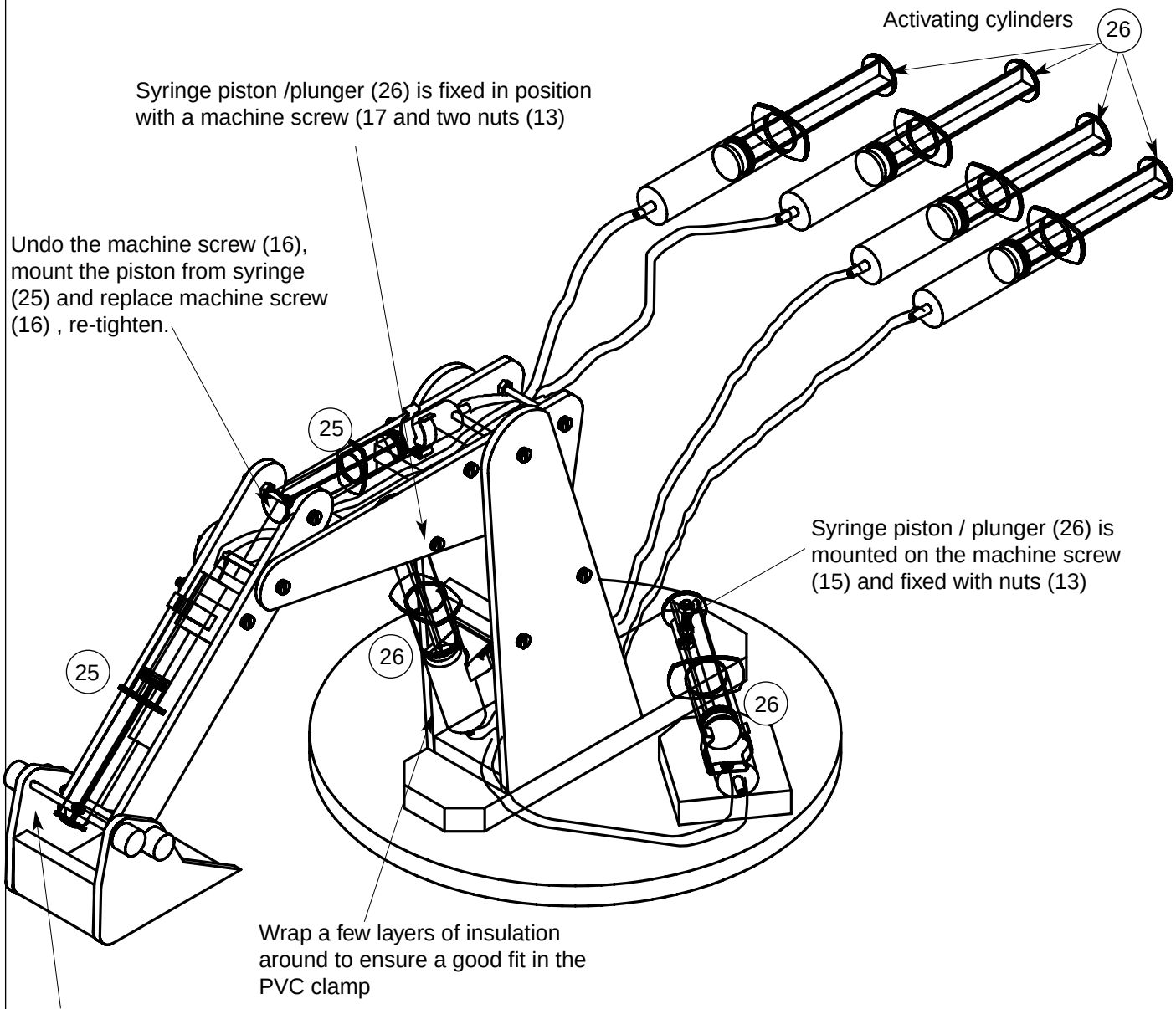
Note: Tighten the machine screws and nuts to their original position.!

Clamp the large cylinder in the spring clip on part (5a)

6.7.12 The system with the syringes (26) and the tube (27b) activates arm 1.
Remove the machine screw (17) and then thread the syringe (26) with the drilled hole under the carrier 5b and the plunger held with the machine screw (17) and two nuts (13) which must be re-inserted. The syringe body is clamped in the PVC holder (23/24)

Note: Wrap 5-6 turns of insulation tape around the cylinder to ensure that it is a tight fit.

6.7.13 The system using the syringes (26) and the tube (27a) serves to activate the base Syringe (26) with the hole in the system plunger must be threaded under the carrier (5b) and the fixed to the machine screw in the base arm (15mm in arm) and held with a nut (13) the other syringe is clamped in the spring clip (22)



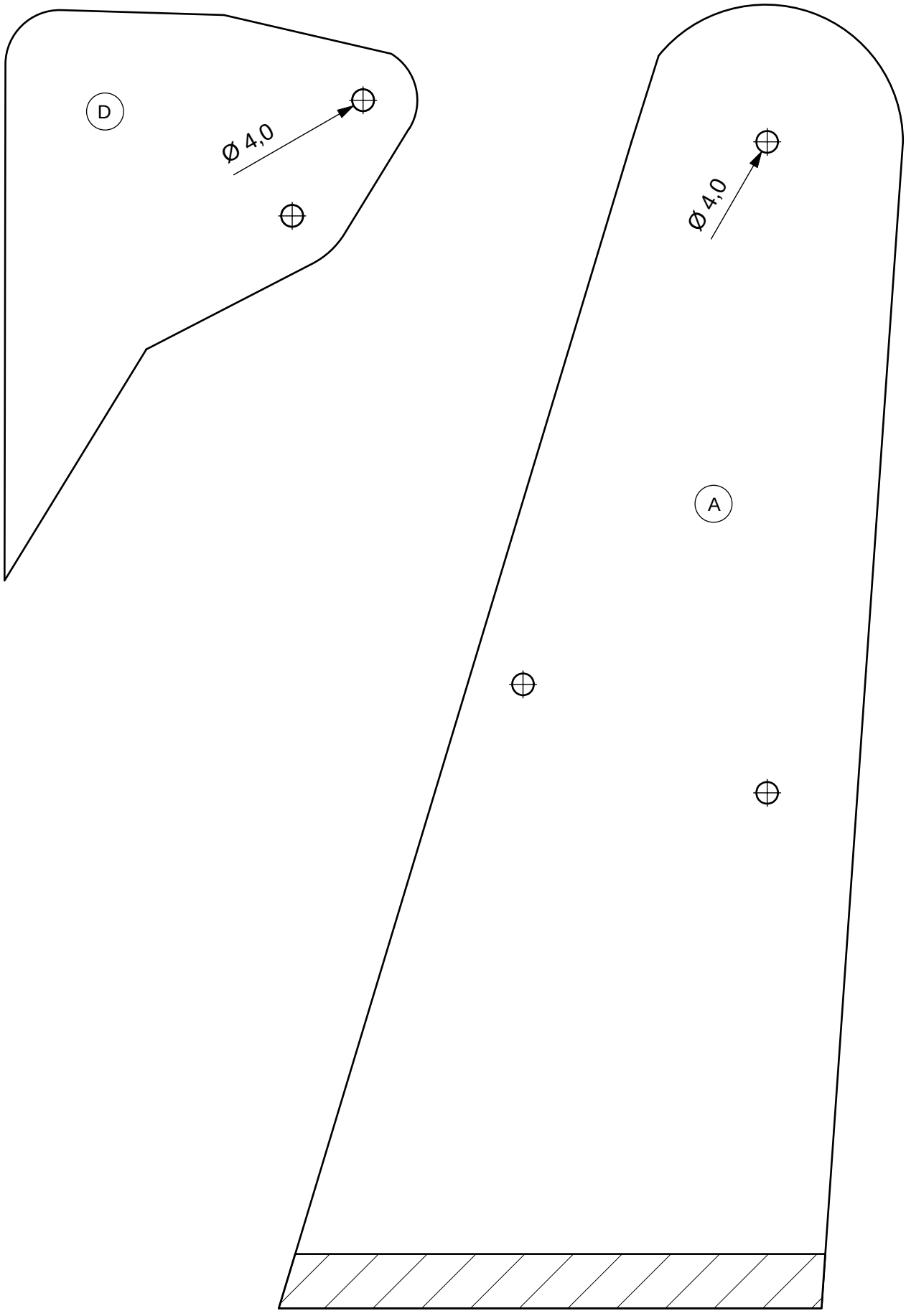
6.7.14 **Testing:**

Each system must be tested individually to see that it does not leak and that is activates the correct part. By adjusting the syringes in their clamps the optimal position can be found.

6.7.15 Once everything has be set up and has been tested and is seen to be working the wooden discs (12) can be glued on the dowels (11) to complete the bucket.

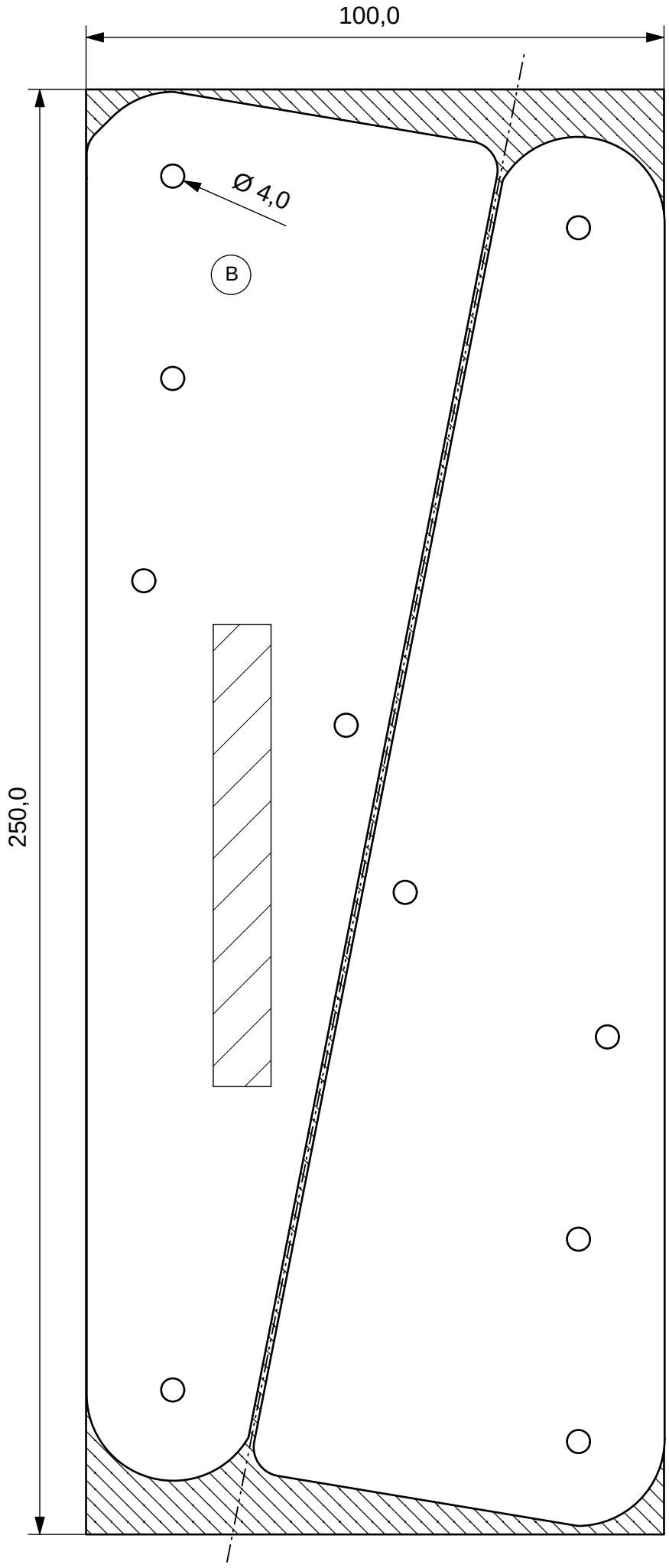
7. Patterns A & D

Scale 1 : 1



7. Pattern B

Scale 1 : 1



7. Pattern C

Scale 1 : 1