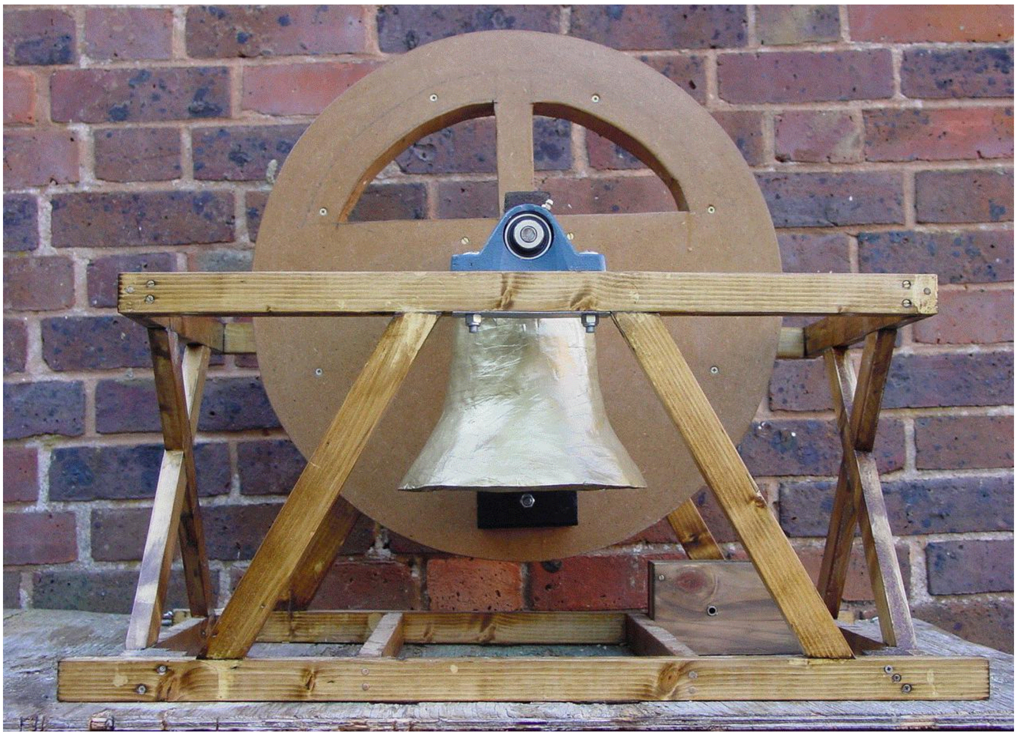
Building Your Own
Mini Dumbbell



Introduction

There is nothing particularly ‘hi-tech’ or complicated about constructing a mini-dumbbell. The difficulty is not in designing and constructing a dumbbell, it is in designing and constructing one that handles well and is a pleasure to ring.

There are a number of factors to be juggled. How large and heavy to make the wheel, what weight to add to the wheel to represent the non-existent bell, and where to put it, to name just a few. Too little out-of-balance weight and the dumbbell is likely to feel uncomfortably sluggish. Too much and the comfortable ringing speed may be unacceptably fast.

The notes that follow describe one particular design. It is intended to be functional rather than beautiful but does aim to represent loosely a bell in a traditional frame. The design is large enough to feel realistic, yet small enough to require little space and impose minimal stress on the supporting structure. It uses an MDF wheel, 22¾" in diameter, 1¾" thick and weighing approx. 12 lb, with cutouts in the upper quadrants and 6 lb of steel weights attached to the lower half. The wheel is mounted on a headstock in a softwood frame approx. 29" long and 17" wide, the overall height being 27". A ½" spindle through the headstock runs in self aligning ball bearings and a papier maché bell is fitted to the headstock.

I don’t claim that the design is perfect, or anywhere near it, but I do believe it that it represents a practicable solution, satisfying to ring but small enough to be installed in the average loft without taking up excessive space or imposing unacceptable stresses on the structure. It has the added advantage that it represents a worked out solution, minimising thinking and experimenting time for the would be constructor. The total cost of the materials in the dumbbell is barely £100, and, depending on materials to hand, could be significantly less. The approximate construction time is 30 hours.

Dimensions have generally been given in both metric and Imperial units. Most dimensions are not critical. The alternatives have sometimes been chosen for convenience rather than being highly accurate conversions. Work, therefore, to one system or the other, not a mixture. (The discerning eye will soon realise that the design was conceived in Imperial units but influenced by the availability of materials in metric sizes.)

The overall size has been chosen with economy, space limitations, user satisfaction, and support stresses in mind. Scaling up might well produce a nicer ringing machine but with greater stresses on the supporting structure and less economical use of materials, particularly sheet MDF. Conversely, scaling down significantly would be likely to produce a dumbbell too small and fussy for enjoyable ringing.

Apart from normal hand tools an electric drill is almost essential and, for the construction of the wheel, a jig saw is very useful. Even better in the pursuit of a truly circular true-running wheel would be the use of a bandsaw, though this is not essential as a small amount of run out is unlikely to cause ringing difficulties.

Construction has been broken down into stages, as described in the following pages. The description is not as fully comprehensive as I would like but it will, I trust, prove adequate.

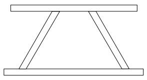
Please Note:
The information in this leaflet is given in good faith. However, it is up to the would-be constructor to satisfy him or herself that he/she is not carrying out tasks that he/she considers are either unsafe or beyond their competence.

The Frame

See Drawings FRAME and ENDBRACE.

Materials: Softwood 19mm x 33mm and 12mm x 33mm
Dowels, 6mm dia. x 33 mm

Suggested construction technique:-



Side frames (2 required)

1. Cut the members for the two side frames. For each frame clamp the four pieces firmly in position. (It may be worthwhile making a trapezoidal template of the central aperture to ensure the parts stay in the correct alignment). At each joint in turn drill two holes through the horizontal member into the diagonal and insert glued dowels. Standard dowels will not be long enough so punch them down or tap a half-length dowel through after the first. Before the glue has set tap all the joints tight. Measure the frame height at both ends and if necessary adjust by pressing the high end down slightly until the height is equal at both ends. Allow to set.

2. Cut the four end pieces to length and assemble to the side frames on a flat surface with corner clamps. At each corner drill two holes through the horizontal rails into the end pieces and insert glued dowels. Tap all joints tight, check for alignment and rightangled joints and allow to set.

Top corner joint

3. Cut and fix the two additional cross members to the base, ¾" in from the end pieces.

4. 

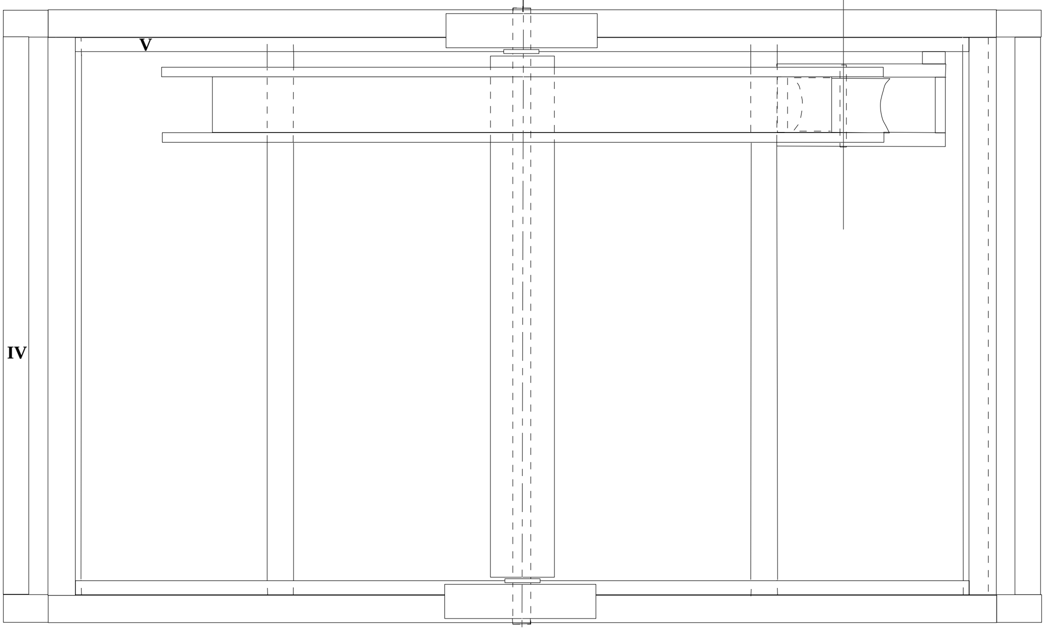
Bottom corner

Cut the pieces for the two cruciform end braces (See Drawing ENDBRACE). For each end brace in turn, cut as shown and join the diagonal members with a glued cross half joint. When set, offer the diagonal braces to the frame and trim to length to suit. Clamp and drill through the top rail and the inner bottom rail (directly below the top rail) into the ends of the braces and insert glued dowels.

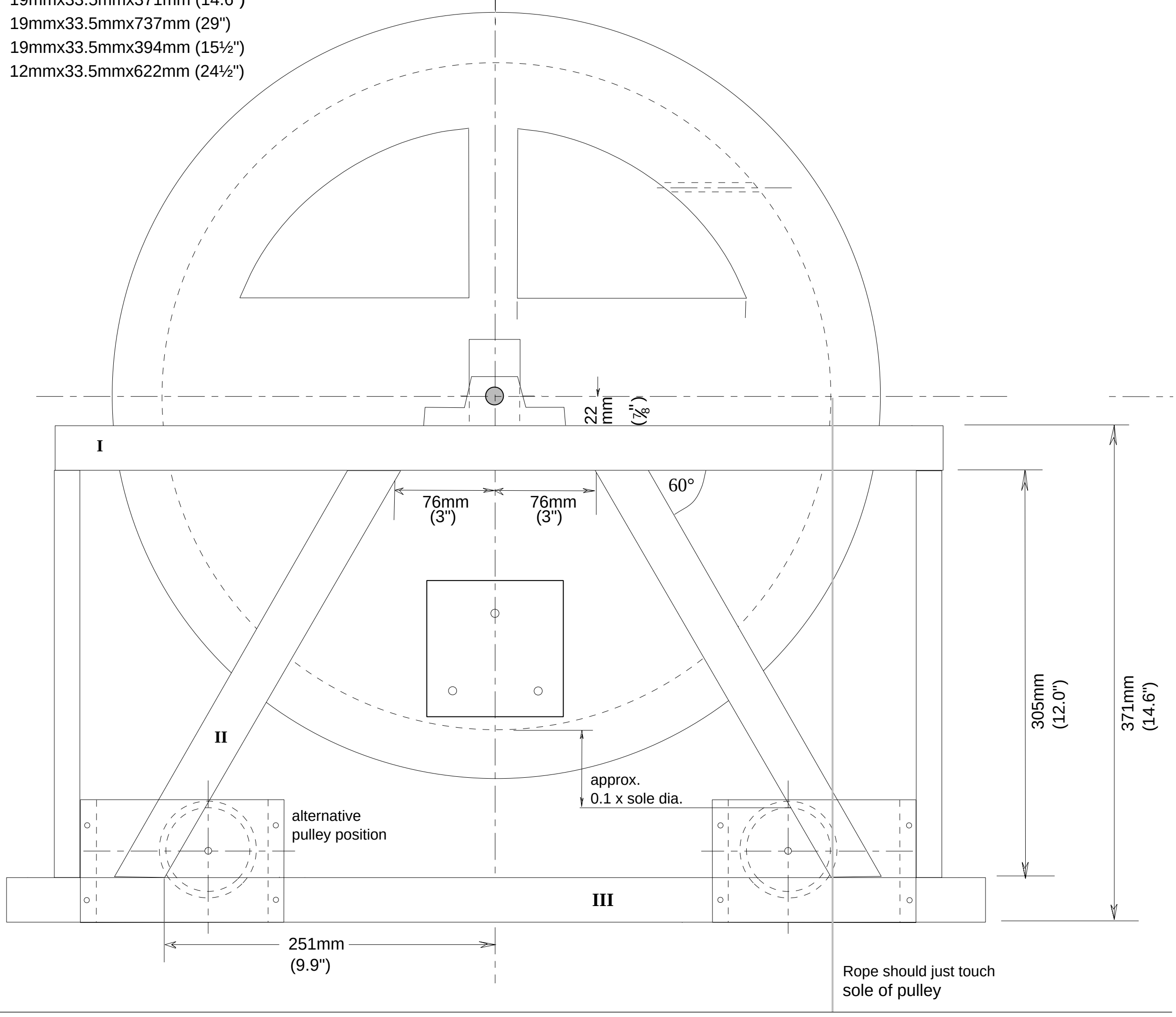
5. Cut and glue the longitudinal pieces inside the top members of the side frames. Note that these pieces are only 12mm (½") thick. (Similar pieces can be fixed inside the top end members if desired).

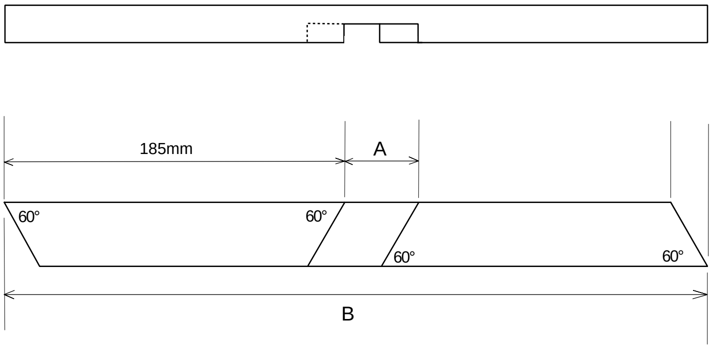
6. The remaining cross members for the base of the frame *can* be added now. However, they are better delayed until after the pulley block is complete and in position. The appropriate cross member can then be placed exactly against the end of the block.

Note:
I favour the use of dowels, not least to minimise the risk of splitting when fixing into end grain. If using screws, I suggest 1½" or 1¾" x No.8, drilling a 2.5mm pilot hole into the end grain (and a 4.5mm hole in the outer piece), and applying PVA glue to the screw thread.



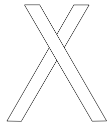
Item	Qty	Dimensions
I	2	19mmx33.5mmx660mm (26")
II	4	19mmx33.5mmx371mm (14.6")
III	2	19mmx33.5mmx737mm (29")
IV	8	19mmx33.5mmx394mm (15½")
V	2	12mmx33.5mmx622mm (24½")





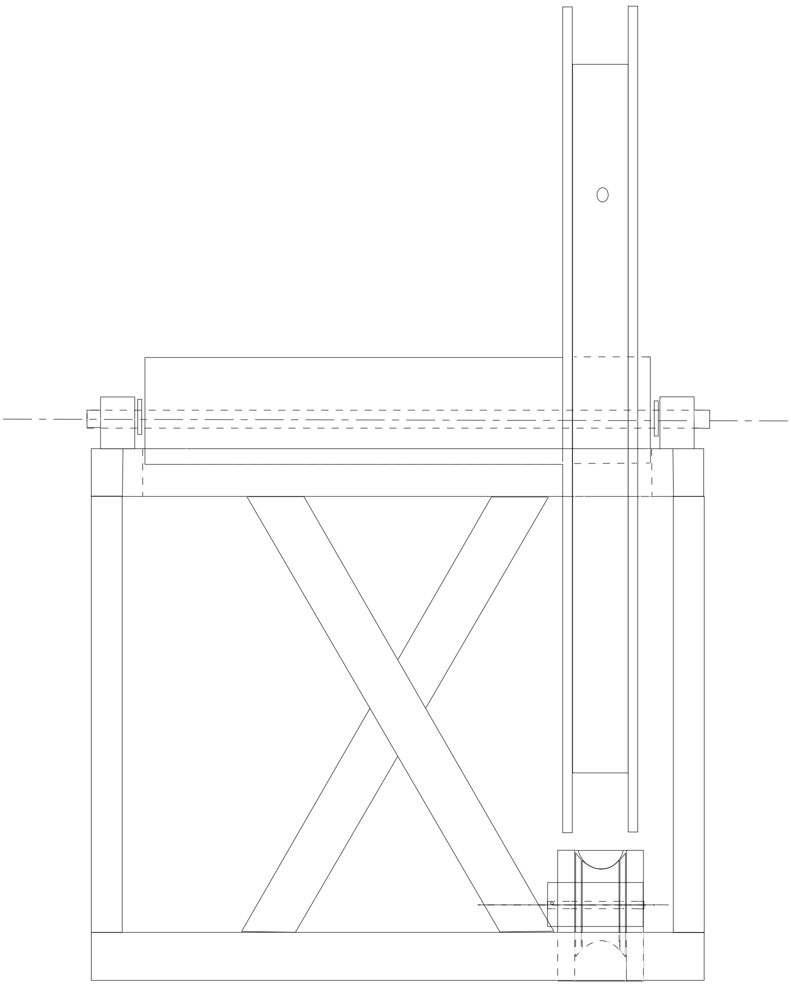
Cut two pieces to the dimensions shown and glue and notch together.

Note that the X is not exactly symmetrical. Fit to the frame with the longer limbs at the bottom,
i.e. much exaggerated:-



Dimension A to suit wood, e.g. 38mm for 33mm wood
Dimension B to be not less than 375mm (14¾") initially and then trimmed to suit frame during fitting
Slot depth to be half wood thickness

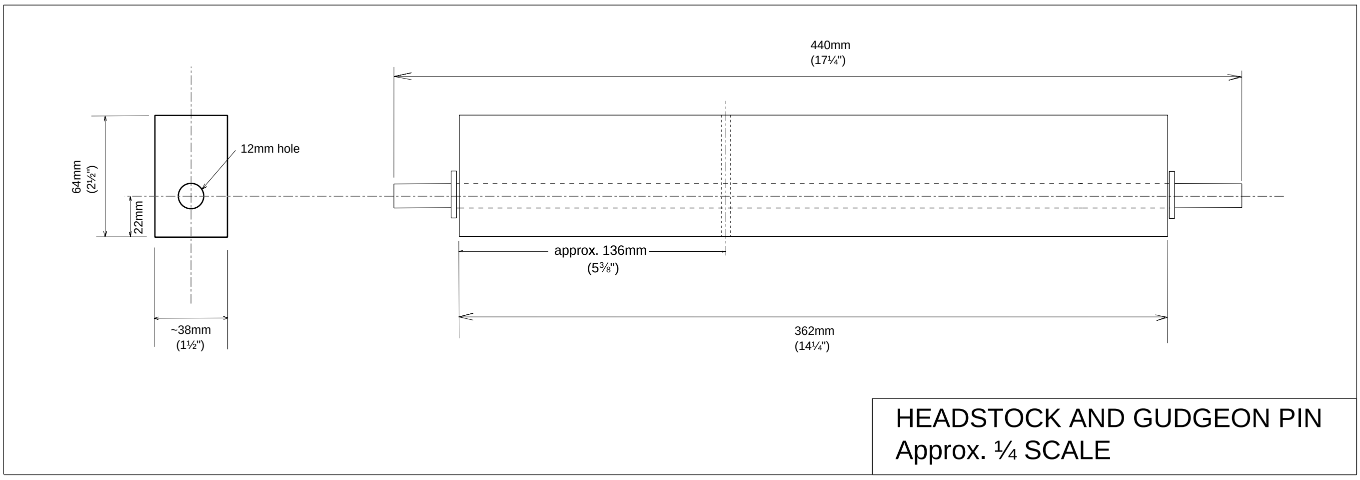
ENDBRACE
Approx. ¼ Scale



Note:
Imperial dimensions may not be exact equivalents
Work in one system or the other

FRAME
Approx. Scale 1:5

The Headstock and Gudgeon Pin



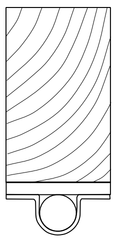
The headstock is made of softwood, approx. 64x38mm.
The gudgeon pin is a 440mm length of 12mm dia. or ½" dia. steel rod. (The bearings must suit the pin diameter!)

The favoured design, as shown, has the gudgeon running right through the headstock. Achieving this without specialist equipment is not entirely straightforward! However, it can be done by clamping the stock in the vice and drilling through from each end with a series of drill bits of increasing diameter and length, starting with 2mm dia. and culminating with a 13mm bit. (The slight oversize of a 13mm bit will compensate for any slight misalignment of the holes where they meet in the centre of the stock). The tendency of the drill to run in the end grain can be prevented by clamping a piece of pre-drilled steel angle to the end and drilling through this. Keeping the drill parallel with the stock can be achieved by careful observation (a second pair of eyes is helpful). The use of a suitable drilled spacing block and a long piece of steel angle, clamped to and extending from the stock as a guide bar, will help.

Slight misalignment of the hole in the stock is not critical. It can be compensated for when the stock is glued to the wheel by ensuring that the wheel is true to the gudgeon rather than the stock.

Once the hole is clear all the way through the stock, dribble PVA glue (or silicon sealant) copiously into it and insert the gudgeon pin, tapping it through until it protrudes an equal amount at each end. It should require no more than gentle tapping. If it requires considerable force the hole may not be straight, causing the pin to take up a curve and preventing the bearings from running freely. [See the Mock Bell section before drilling the hole for securing the bell].

If drilling right through the headstock seems too daunting there is an alternative:
Shorten the length of stock so that it butts up against the wheel instead of passing through it. Drill the wheel to accommodate just the gudgeon pin. Fasten the gudgeon pin to the base of the stock, for example using suitable saddle clips. For a better job secure the pin by saddles and machine screws to tapped holes in a steel plate and then secure the whole plate to the base of the headstock.



Another option is to cut the headstock along the intended centre line of the pin and use a router to cut half-depth slots for the pin, screwing and glueing the parts together on assembly.

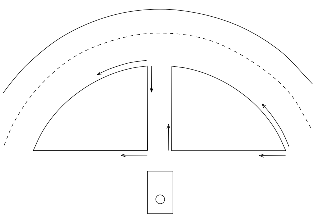
The Wheel

Safety Note
There are safety concerns about the dust produced when working with MDF. Wearing a suitable mask and using vacuum dust extraction with power tools are sensible precautions.

The wheel comprises a core of two discs of 18mm MDF (or 3 discs of 12mm) and two outer discs of 4mm MDF, all screwed and glued together. The wheel, with the cutouts in the top two quadrants, weighs about 12 lb.

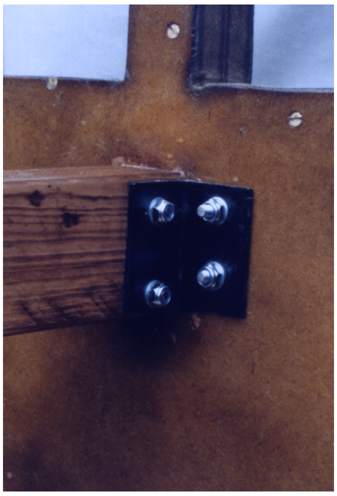
Cut and assemble the core first. Ideally the core discs should be cut on a band saw, after glueing and screwing, to ensure circularity. However, acceptable results can be achieved using a jig saw. In this case it is better to cut the discs before glueing as cutting 36mm MDF with a jig saw is slow work and it is not easy to ensure the blade remains vertical. A good old-fashioned spokeshave can be used for trueing the discs. Then cut and fix the outer discs to the core.

The slot for the headstock needs to be carefully matched to the actual cross-section of the headstock and also needs to take account of any inaccuracy in the position of the gudgeon pin in the stock. Drill a hole (½" or 12mm dia. to suit the pin) in the exact centre of the wheel. Decide and mark which end of the headstock is to fit in the wheel, offer up the stock and insert the gudgeon pin in the wheel. Mark carefully round the end of the stock and cut the slot in the wheel. If the pin is exactly correctly aligned in the headstock and if the slot in the wheel can be cut accurately make the slot a tight fit around the headstock. If not (if for example using a jigsaw to cut the slot and then trimming with a sharp chisel) make the slot fractionally oversize to allow a little ‘wobble’ about the correct alignment, correcting at the glueing stage.



Next, mark the two quadrants in correct relation to the headstock slot and cut them out. This can be done successfully with a jigsaw, first drilling a 10mm hole near each corner. Care is required to keep the jig saw blade perpendicular to the work and make a neat job. It's best to cut the spoke edges first, cutting the two edges in opposite directions. When doing the other quadrant edges, start from one side and work right across/round. Any errors from the blade not being exactly vertical should then be symmetrical.

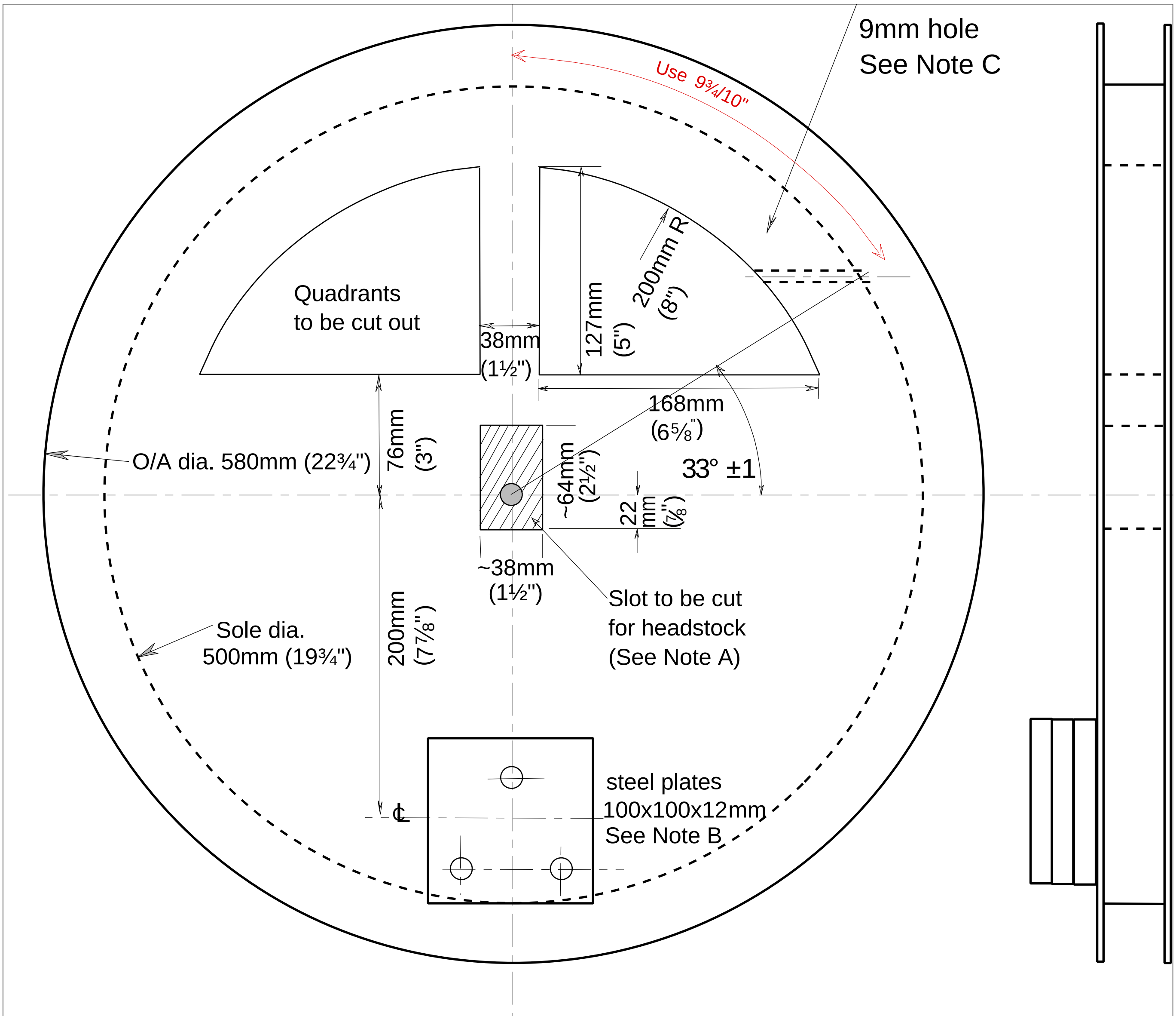
When the quadrants have been cut out, glue the headstock into the wheel. Apply a liberal liberal quantity of PVA glue to the slot in the wheel and insert the headstock, allowing it to protrude approx. 10 to 11 mm through the far side. Check that the wheel is at right angles to the gudgeon pin. [The best method of doing this is to set up the stock and wheel in its bearings in the frame and adjust the wheel on the stock until it runs true. Very thin softwood wedges may help to achieve this]. Allow to dry.



Angle bracket between stock and wheel

Add angle brackets if desired. If using brackets made to the design shown (Drawing HEADSTOCK to WHEEL BRACKETS) make sure that the brackets are fixed level with the base of the headstock, to avoid the lower fixing bolts fouling the gudgeon pin. Alternatively, use proprietary bracket, for example B&Q 40x40x60mm perf. brackets, bar code No. 5010845711097.

Bolting on the weights and drilling the garter hole may be left until the wheel is in the frame.



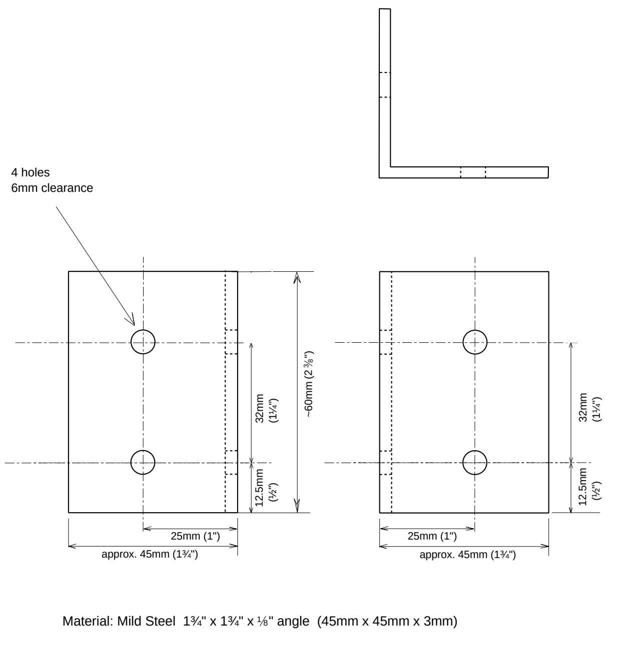
Wheel made of MDF.
Flanges: 4 or 6mm thick
Core: 36mm thick (2 layers of 18mm or 3 of 12mm)

Note A: The dimensions and position of the rectangular slot must be such that when the stock is glued and inserted in the stock:-
(1) The gudgeon pin is at the centre of the wheel
(2) The gudgeon pin is at right angles to the wheel
(3) The headstock is vertical with respect to the two cut out quadrants

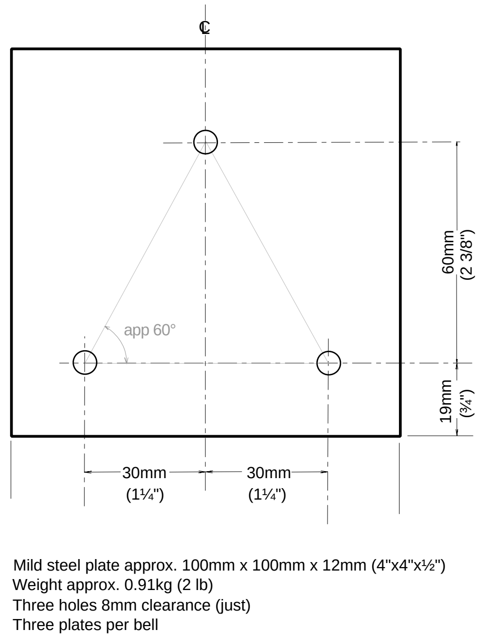
Note B: The steel plate/s should total 36mm (~1½") in thickness and be bolted right through the wheel [See Drawing WEIGHTS].

Note C: The garter hole (and the pulley block, not shown) need to be on the correct side of the wheel to suit the rope fall.

WEIGHTS
Approx. ¼ Scale



HEADSTOCK to WHEEL BRACKETS
Approx. ½ Scale



WEIGHTS
approx. ½ Scale

Bearings

Use self aligning ball bearings, 12mm or ½" according to the diameter of the gudgeon pin. Typically, quality English bearings (e.g. Ransom Hoffman Pollard, ref NP 12 - RHP [12mm] or NP ½ RHP [½"]) cost about £40 a pair even with maximum discount. Cheaper, but entirely adequate, bearings of Chinese manufacture can be bought from, for example, Midland Bearings (www.MidlandBearings.com). Their stock description, for bearing blocks to suit ½" rod, is:-
UCP201-8S FK Bearing Unit Small Casting Type NP 1/2"

The fixing holes in the bearing housings are large enough to accommodate 12mm bolts but holes in the frame to accommodate bolts so large would be excessive and possibly weakening. 8mm bolts are more than adequate but will need sleeving where they pass through the fixing holes in the bearing housings.

The bearings should be mounted with the protruding part of the bearing itself facing inwards (to ensure adequate clearance between the bearing housing and the end of the headstock), with 12mm packing washers on the pin at either end of the headstock. The bearings, being self-aligning, have a spherical outer surface able to swivel within a matching surface in the housing. Check that the bearings are free to move and ensure that they are correctly aligned when mounting them on the frame. As a check, rotate the wheel to the fully inverted position and release it. With the weights attached it should swing at least 70 times before coming to rest.

Bearing mounting

Weights

A design for steel weights totalling 6 lb is shown on Drawing WEIGHTS. The fixing position is shown on Drawing WHEEL.

Alternative designs and materials may be used, according to what it to hand. However, it is recommended that the total weight is in the 6 to 10 lb range. Adding weight below the headstock will increase the natural speed of rotation. The effect can be reduced by moving the weight nearer to the headstock or by adding weight above the stock.

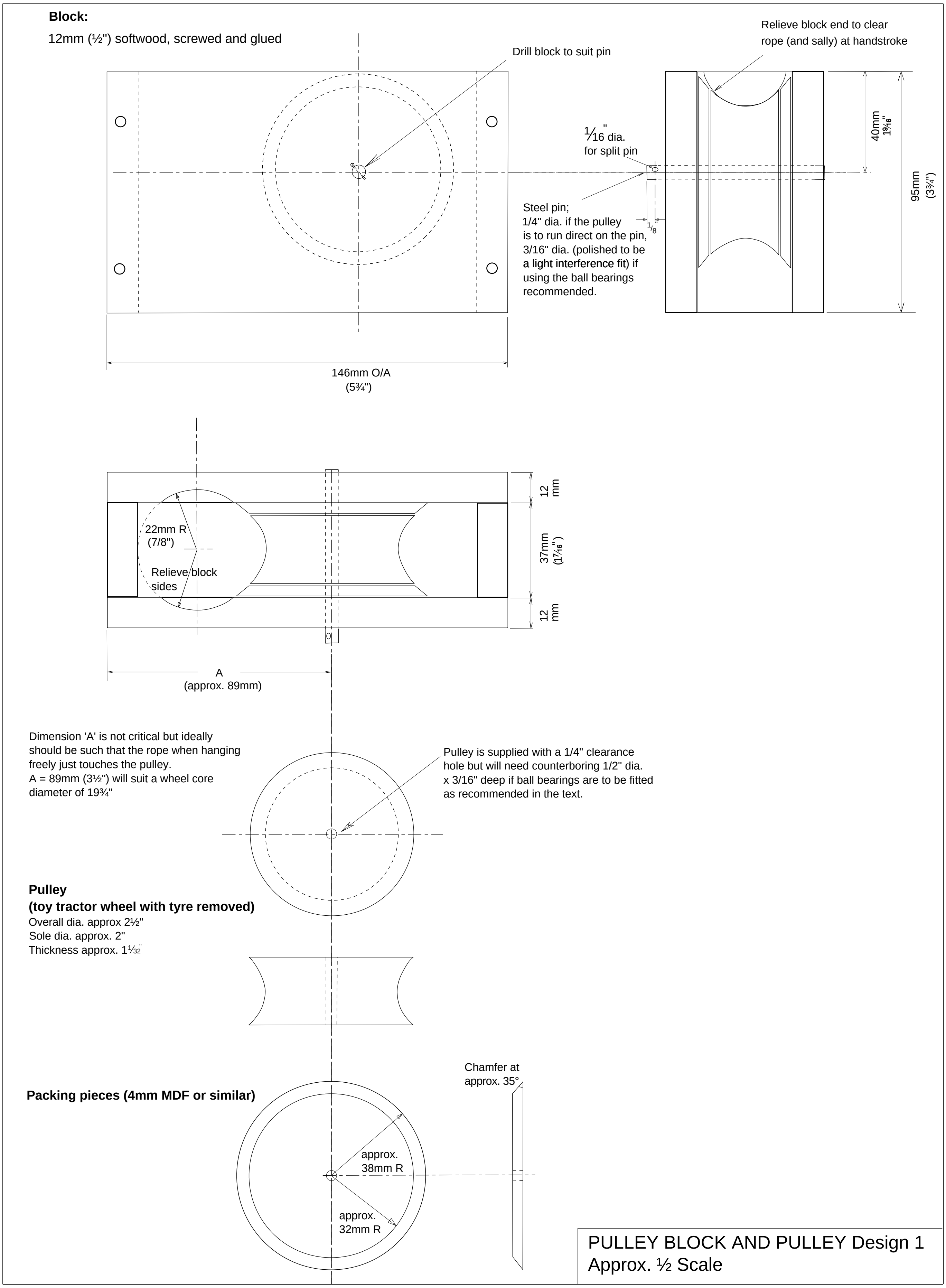
Pulley Block

The design shown on Drawing PULLEY BLOCK AND PULLEY Design 1 uses a proprietary 'pulley', 2½" in diameter and 1 $^{1}/_{16}$" wide. Such pulleys are actually toy tractor wheels, with the tyres removed, and may be obtained from, for example, Hobbies Ltd., Units 8b-11, The Raveningham Centre, Beccles Road, Raveningham, Norwich NR14 6NU, (www.alwayshobbies.com). The overall diameter before tyre removal is 100mm. The pulley will run adequately on ¼" dia steel axle rod (obtainable from Hobbies Ltd) but a better arrangement is to run it on $^{3}/_{16}$" dia road and counterbore the pulley to take ball bearings to suit [e.g. R3-2RS Ball Brg (KLNJ3/16-2RS)] from Midland Bearings.

The location of the pulley should allow the rope, when vertical, just to touch the groove. When the bell is 'up' at handstroke, the rope should fall slightly below the horizontal on its way from the wheel to the pulley. The upper groove should be below the sole of the wheel by about 1½" to 2" (for the wheel size described) or, in the general case, about 0.1 x the sole diameter of the wheel.

The pulley block will need spacing away from the bottom side rail of the frame by the correct amount to ensure that the pulley is in line with the wheel. The exact thickness of packing required will depend on the accuracy with which the frame has been built but should be approximately 19mm (¾"). Small adjustments can be achieved by using suitable washers between the headstock and the bearings to move the stock slightly with respect to the pulley block.

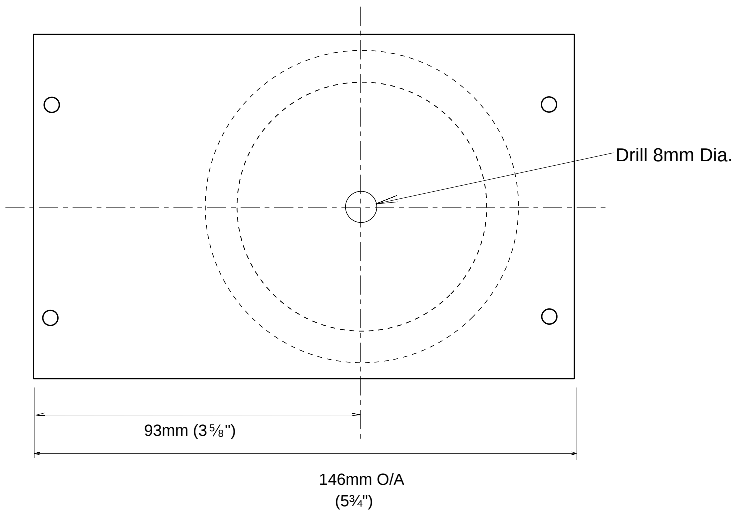
An alternative design, using a wood or MDF pulley running on a plain pin, is shown on Drawing PULLEY BLOCK AND PULLEY Design 2.

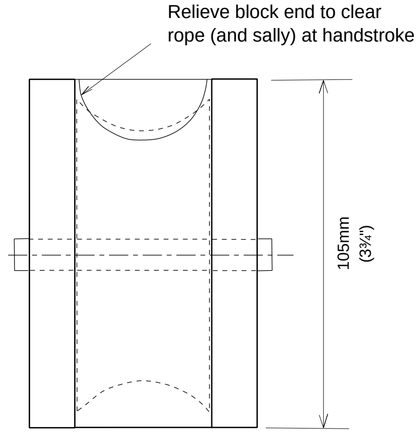


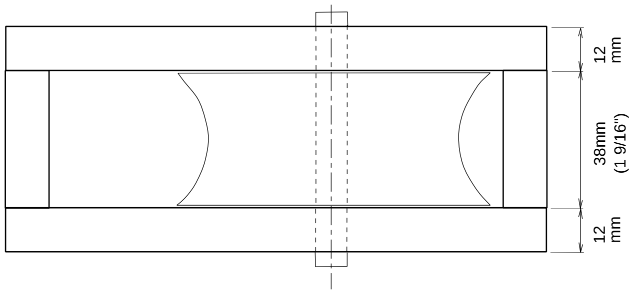
Block:
12mm (½") softwood, screwed and glued
Drill block to suit pin
Relieve block end to clear rope (and sally) at handstroke
1/16" dia. for split pin
Steel pin; 1/4" dia. if the pulley is to run direct on the pin, 3/16" dia. (polished to be a light interference fit) if using the ball bearings recommended.
1/8"
40mm 1 9/16"
95mm (3¾")
146mm O/A (5¾")
22mm R (7/8")
Relieve block sides
12 mm
37mm (1 7/16")
12 mm
A (approx. 89mm)
Dimension 'A' is not critical but ideally should be such that the rope when hanging freely just touches the pulley. A = 89mm (3½") will suit a wheel core diameter of 19¾"
Pulley is supplied with a 1/4" clearance hole but will need counterboring 1/2" dia. x 3/16" deep if ball bearings are to be fitted as recommended in the text.
Pulley
(toy tractor wheel with tyre removed)
Overall dia. approx 2½"
Sole dia. approx. 2"
Thickness approx. 1 1/32"
Packing pieces (4mm MDF or similar)
Chamfer at approx. 35°
approx. 38mm R
approx. 32mm R
PULLEY BLOCK AND PULLEY Design 1
Approx. ½ Scale

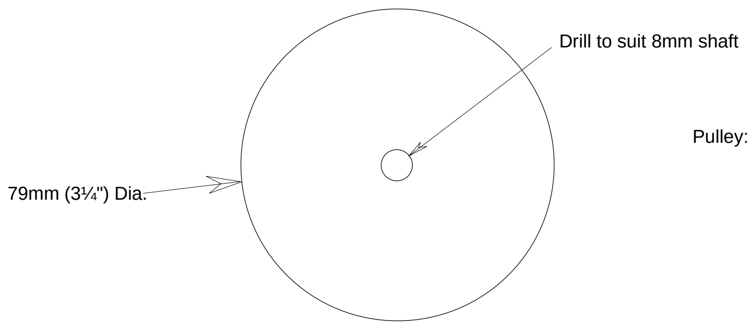
Block:

12mm (½") softwood, screwed and glued

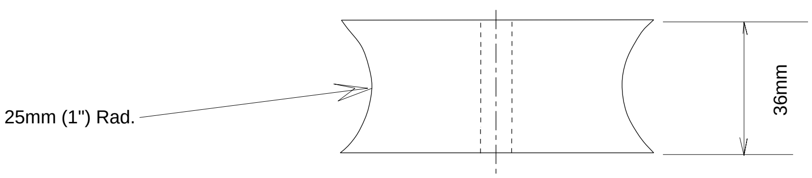








Pulley: Lightweight hardwood or
suitable alternative, e.g.
2 layers of 18mm MDF glued together.



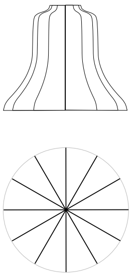
PULLEY BLOCK AND PULLEY Design 2
Approx. ½ Scale

Mock Bell

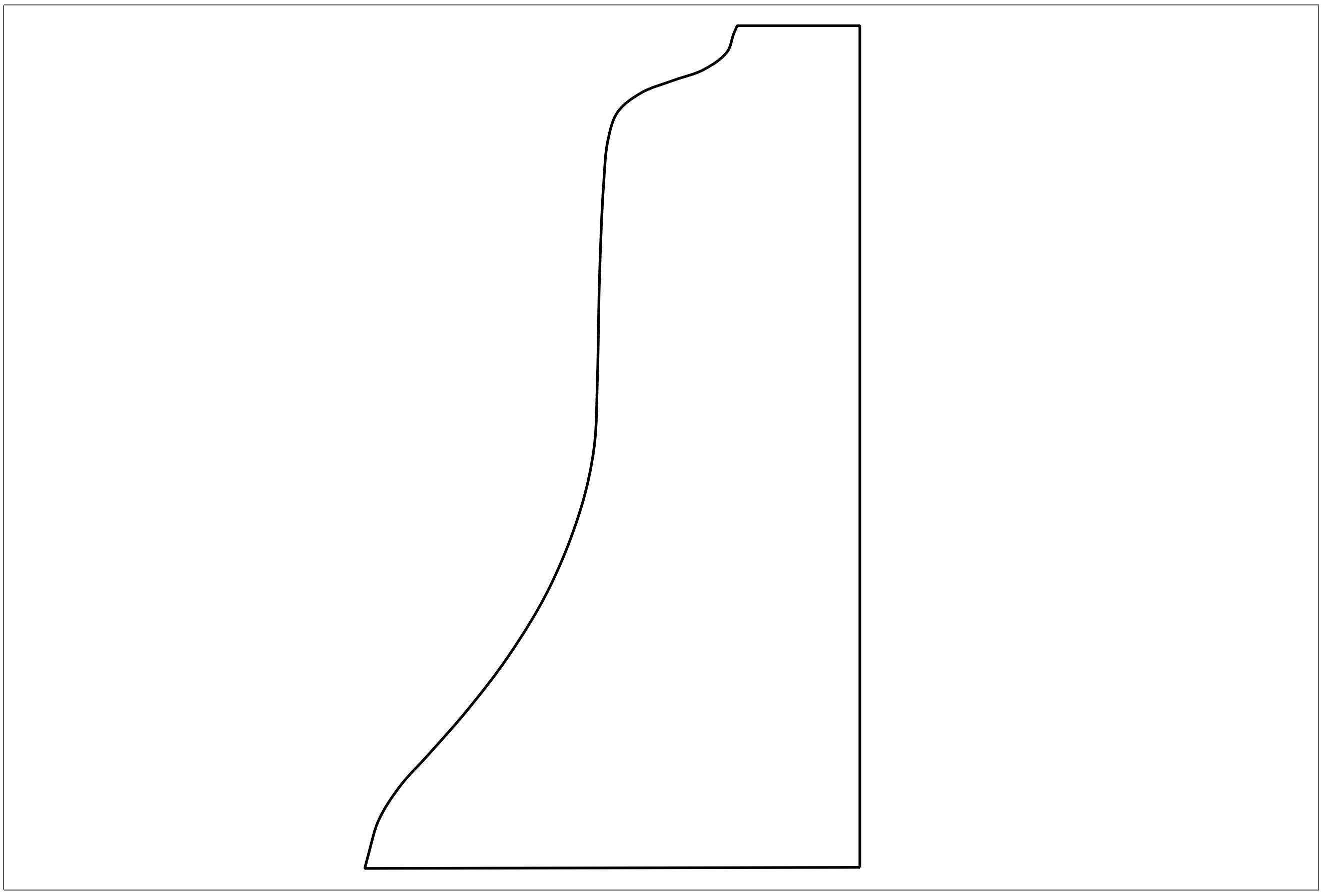
A mock bell, though not essential, does add to the overall visual effect. However, acquiring or making a suitable bell, which should be no taller than 8¼" and no wider at the mouth than 10¼" in diameter can present problems (*revised from 9" and 10¾", 27 Sept 05).*

A wedding supplier might be able to supply a suitable plastic bell but failing this, at the most basic level a suitably sized plastic flower pot could suffice. At the other end of the scale an elaborate mould could be constructed to enable a mock bell to be made in grp. A reasonable compromise is to construct a bell out of strips of newspaper glued with PVA glue, laid up over a former. About 6 layers of paper will be found enough to produce a suitably rigid bell.

The former can be made by sticking a number of templates of a half bell radially on a base and laying plaster of paris bandage (obtainable from model shops or use rag strips soaked in patching plaster) over the templates to form the shape of the bell. When the plaster bandage has set, the surface can be filled with further plaster as necessary, smoothed to a uniform profile, painted with a layer of PVA glue and sprayed with clear lacquer. A large number of templates will help to produce a good shape but will increase the difficulty of joining all the templates at the centre. The difficulty can be eased by sticking the vertical edges to a (say 1" dia.) piece of dowel, reducing the width of the templates to suit the thickness of the dowel.



Plan (reduced scale) showing twelve templates stuck to a base and stuck at the vertical join.



Template of half bell, half size

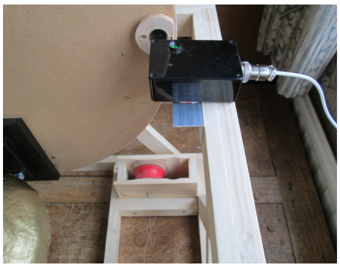
The bell will tend to shrink as it dries making removal from the former difficult. Greasing the former and covering it with cling film before laying up the paper will help.

Once finished and sprayed, the mock bell can be screwed to the underside of the headstock. More robustly, and serving also as an additional locating feature for the gudgeon pin in the stock, a hole can be drilled right through the stock and pin and a 5M or 6M machine bolt or screw passed through stock, pin and bell and secured by a nut and large washer inside the bell. The hole should be approx. 136mm from the free end of the headstock.

Mounting the Sensor

Mounting the sensor will depend on the type being used.
Here are views of typical sensors and mountings

Bagley Sensor
(mounted on a small L-shaped bracket with the open end of the sensor head approx. 3" from the wheel and the reflector strip fixed to the wheel in the right position to be line with the sensor head with the bell mouth down)



Hall effect sensor
(mounted in a similar position to that shown in the picture above for the Bagley sensor but with the face of the sensor box approx. 1¼" (30mm) from the face of the magnet and the LED just left of the magnet centreline.)

Induction sensor [Aidan Hedley circuit]
(mounted 'behind' the wheel, as shown.)

Finishing

MDF has a tendency to absorb moisture. To prevent this and any risk of warping if the dumbbell is in a damp location the wheel should be sealed. Cosmetically it is advisable to varnish the frame as well.

Ceiling Boss

A ceiling boss can be made from one or more layers of plywood. The hole for the rope should be approx. 1¾" in diameter. The boss should have a square base, which can be secured to a ceiling either by screws at the corners or by PVA glue.

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E&OE

Sept 2005 with revisions to February 2019
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