A FERRIS WHEEL CLOCK

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deals with the installation and fitting of the Archimedes screw

●*Part X continued from page 488 (M.E. 4182, 15 November 2002)*

The arbor of the Archimedes screw runs in a 2.5mm I/D ball race in the cover and a 5mm I/D ball race which has already been fitted in the ball platform.

The housing for the 2.5mm I/D race should be made next; its dimensions are given in **fig 40**. The race should be an easy sliding fit. The completed housing is secured in the 6mm dia. hole in the cover with Loctite High Strength Retainer.

The dimensions and details of the arbor for the screw were shown in fig 35 on p 486, *M.E.* 4182, 15 November 2002. The dimension indicated between the two races is only a guide; you should measure this distance and allow about 0.25mm end shake. At this stage do not reduce the end of the arbor to 4mm and be sure to leave the length about 10mm longer than shown. The arbor will be finished to its final dimensions when the motor is fitted.

The pitch of the screw was made 15mm and, allowing for the 0.80mm thickness of the thread, the overall length of the screw becomes 15.8mm. The length of the 'U'-shaped entrance from the bottom of the cover to the top of the platform was made 16mm to give a 0.20mm clearance for the screw. The shaft of the screw should now be machined to its final dimensions. Hold the shaft in a collet or 3-jaw chuck and part off the end of the shaft leaving 4mm of the shaft beyond the start of the thread. Reduce the shaft to 7.5mm dia. flush with the start of the thread; this end of the screw will be the bottom.

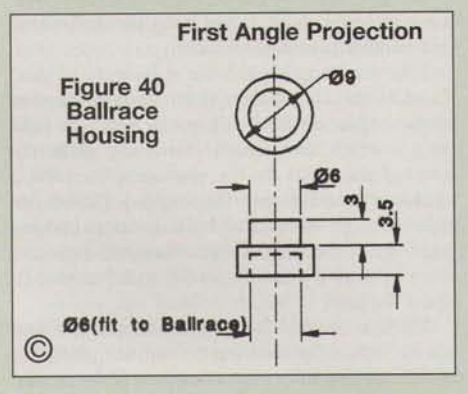
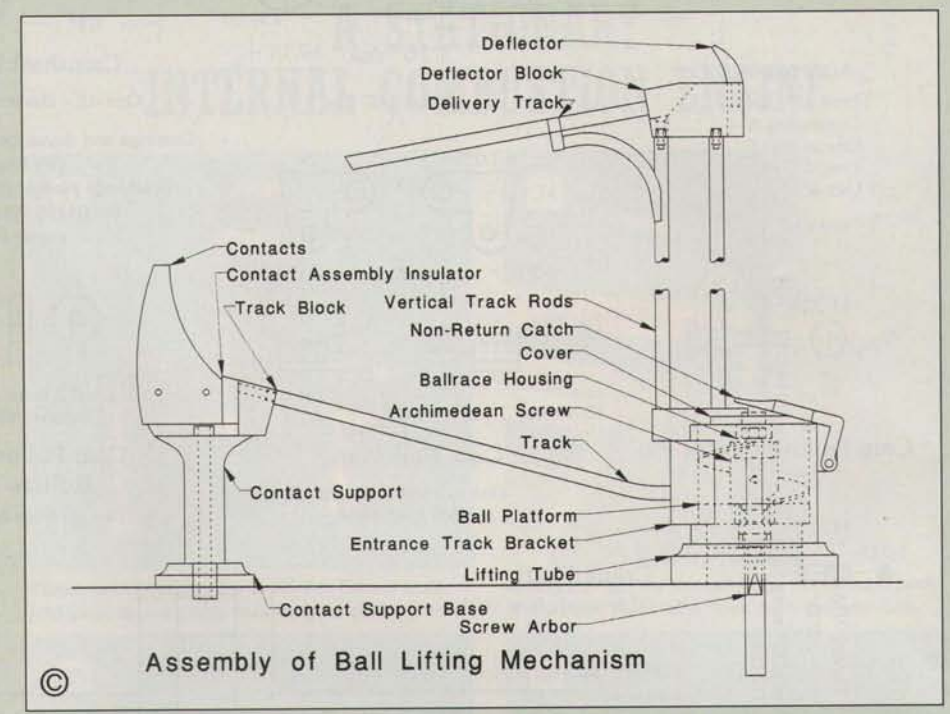


Figure 40 Ballrace Housing

Now hold the end of the shaft turned down to 7.5mm in a collet or 3-jaw chuck and face off the end of the shaft flush with the end of the thread. This is the top of the screw. Bore a 10mm dia. recess in the end of the shaft to 4mm depth. The housing for the 2.5mm race fits into this recess. The screw is secured to the arbor with a 2.5mm dia. grub screw. Hold the shaft in a vice in the milling machine and drill a 2.1mm tapping hole in the shaft on the line joining the start and end of the thread, 8mm from the top of the shaft. Tap the hole 2.5mm and fit the grub screw. When tightened onto the shaft, the end of the grub screw must be just below the surface of the shaft or it will foul the balls as the shaft turns.



Assembly of Ball Lifting Mechanism

Slip the screw onto the arbor. The 4mm section of the arbor should protrude 0.5mm into the recess in the top of the shaft. The length of the arbor can now be adjusted to fit between the ball races. You should aim to have a small amount of end shake. The top and bottom of the thread should just clear the underside of the cover and the top of the platform. The thread still needs some modification before it will pick up and lift balls but this modification must wait until the non-return catch has been made and fitted.

Non-return catch

The dimensions of the non-return catch are given in **fig 41**. You will need a piece of gauge plate (annealed carbon steel) or, if you cannot get any gauge plate, a piece of mild steel 30 x 15 x 10mm. If you use mild steel, the catch will have to be case hardened. The profile of the end of the catch which holds the balls has not been shown in fig 41. This profile will have to be filed to suit after the catch has been fitted in position.

Fitting the catch

Fit the cover in position in the lifting tube and fit the end of the catch into the slot in the hinge at the side of the lifting tube. Mark around the outside of the catch using a sharp scriber and, guided by the scribed lines, mill a 3mm deep recess for the catch in the top of the cover. Drill the hole for the hinge screw in the hinge bracket, beginning with a 1.7mm dia. hole (tapping size for 2mm) through the hinge bracket. The position of the hole is shown in fig 36 (see p 487, *M.E.* 4182).

The hole on one side of the bracket is then enlarged to 2mm. Tap the thread for the hinge screw using the 2mm clearance hole as a guide. Fit the catch in position in the recess in the cover and use the 2mm clearance hole as a guide to mark the position of the hinge screw. Drill the 2mm dia. hole in the catch for the hinge screw.

The hinge screw is best made from a scrap of leaded mild steel. Fit the catch and check that when lifted and released it drops into its recess under its own weight. Before shaping the front profile of the catch, the vertical 3.5mm track rods that hold the column of balls should be fitted to the cover.

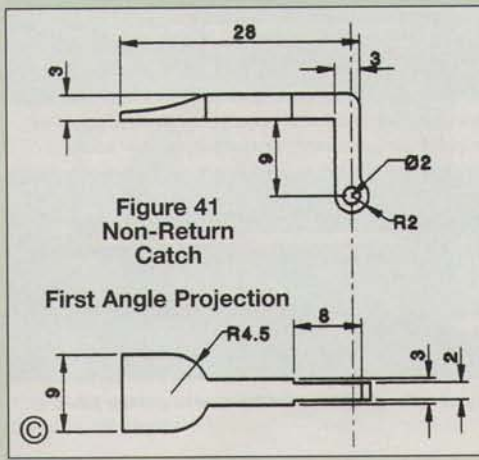


Figure 41 Non-Return Catch

The non-return catch needs some trial-and-error attention in order to achieve the optimum profile.

The deflector block, which requires care in its manufacture, is positioned at the top of the vertical track and delivers the balls to the Ferris wheel.

This view of the deflector block and track reveals its construction. The ball is about to run out onto the Ferris wheel.

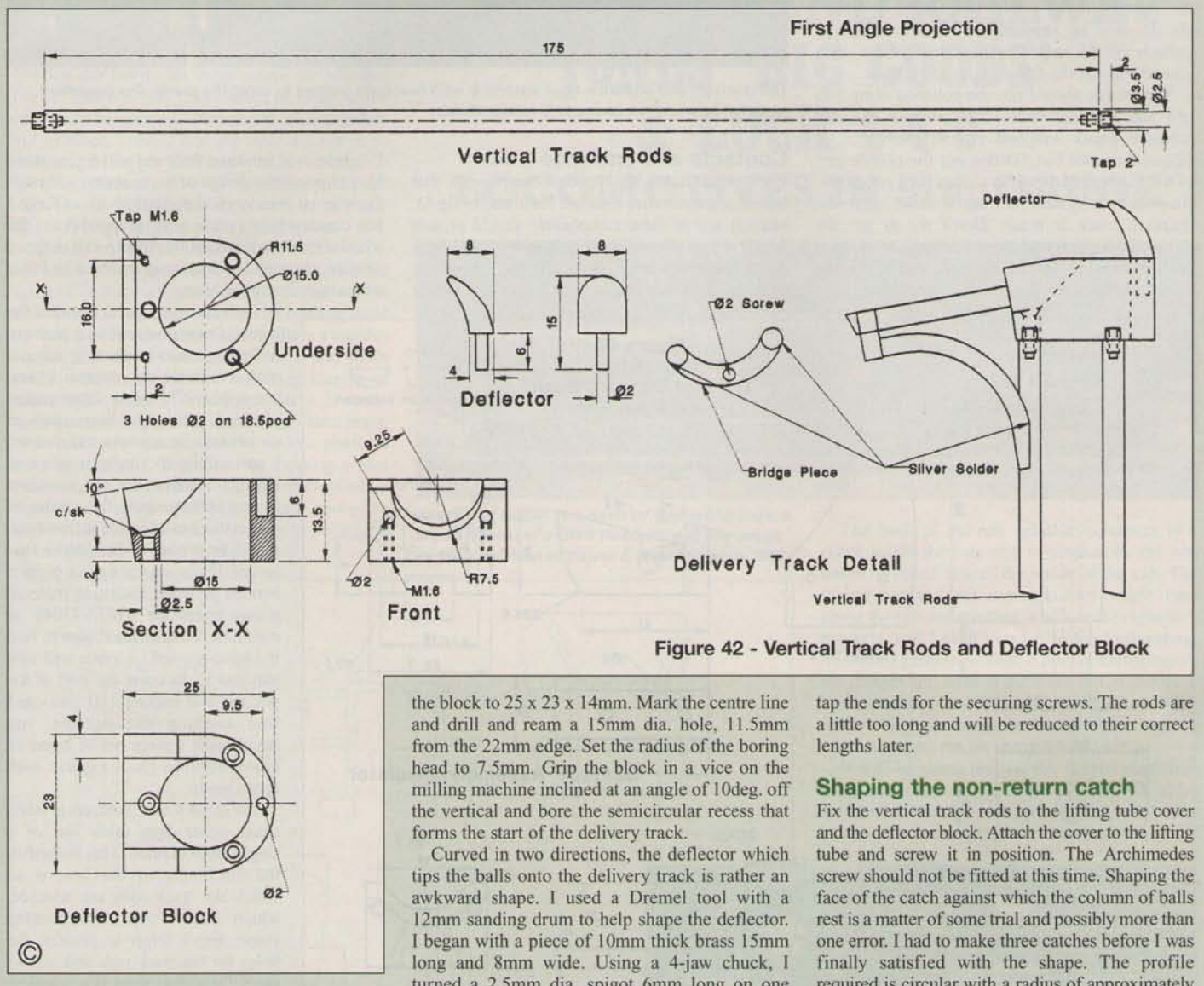


Figure 42 - Vertical Track Rods and Deflector Block

Fitting the vertical track rods

The vertical track rods are attached at the top to the deflector block which tips the balls onto the delivery track. The balls roll down this delivery track until they reach a vacant slot at the top of the Ferris wheel. The dimensions and details of the deflector block are given in **fig 42**. For the block you will need a piece of free machining brass 25 x 25 x 15mm. Begin by facing all sides and reducing the block to 25 x 23 x 14mm. Mark the centre line and drill and ream a 15mm dia. hole, 11.5mm from the 22mm edge. Set the radius of the boring head to 7.5mm. Grip the block in a vice on the milling machine inclined at an angle of 10deg. off the vertical and bore the semicircular recess that forms the start of the delivery track.

Curved in two directions, the deflector which tips the balls onto the delivery track is rather an awkward shape. I used a Dremel tool with a 12mm sanding drum to help shape the deflector. I began with a piece of 10mm thick brass 15mm long and 8mm wide. Using a 4-jaw chuck, I turned a 2.5mm dia. spigot 6mm long on one end. This spigot was fitted into the hole in the block and the outline marked using a scriber. A combination of files and the Dremel tool were then used to shape the deflector.

Drill all the holes for the track rods and track rod screws. Don't forget to ensure that the edges of the track rods are flush with the edges of the holes through which the balls pass. Finally cut the vertical track rods to the length shown and tap the ends for the securing screws. The rods are a little too long and will be reduced to their correct lengths later.

Shaping the non-return catch

Fix the vertical track rods to the lifting tube cover and the deflector block. Attach the cover to the lifting tube and screw it in position. The Archimedes screw should not be fitted at this time. Shaping the face of the catch against which the column of balls rest is a matter of some trial and possibly more than one error. I had to make three catches before I was finally satisfied with the shape. The profile required is circular with a radius of approximately 6mm inclined at about 45deg. to the horizontal. The close-up photograph of my catch will give you an idea of the shape required.

Scribe an arc of 6mm radius and begin filing down to this line, keeping the files inclined at an angle of 45 degrees. When it is supported by the catch, the bottom of the ball is level with the bottom of the cover. To assist with the filing it is as well to use engineer's marking blue to indicate where ▶

to file. Engineer's marking blue is a greasy blue paste used by engineers when scraping the slides of machine tools to achieve a perfect fit. If you don't happen to have a tin of engineer's blue 'acquire' one of the wife's lipsticks, which will serve almost as well. Smear a little blue (or lipstick) on the surface of the catch and gently rub the ball against the catch. This will indicate where the ball is touching the catch.

As soon as you get close to the final profile change to a fine file and finally to 600 grit wet and dry abrasive paper wrapped around a piece of 12mm dia. round bar. Continue taking off the high spots until a ball pushed up through the hole in the cover lifts the catch which drops back when the bottom of the ball reaches the level of the bottom of the cover. If released, the ball-should then be supported by the catch. Now entirely fill the vertical track with balls; the catch should support the full column of 13 balls.

The profile should now be polished using 800 grit and finished with 1200 grit wet and dry abrasive paper wrapped around the piece of 12mm diameter bar. Harden out the profile end of the catch and leave it in a glass hard condition. Re-polish the catch and set it aside until the entrance track is made. Don't try to get the Archimedes screw working at this stage; to function correctly this requires four balls waiting in line on the entrance track.

The contacts and entrance track assembly with four balls waiting to enter the guide. The insulation material between the contacts is clearly visible.

Contacts and entrance track

The contacts and the various components that comprise the entrance track are illustrated in **fig 43**. Making any of these components should present few, if any, problems. The contacts are made from 4mm engraving brass. Some readers may have seen the clock working at recent Model Engineer Exhibitions at Sandown Park and will realise that I have changed the design of the contacts. Although the original ones worked perfectly well, as far as I was concerned every time a ball dropped out of the wheel it made an unacceptable thump as it dropped onto the contacts. The new design works a lot better and is significantly quieter.

The insulating spacer between the contacts may give readers a problem in finding a non-conducting material with a suitable appearance. I used some phenolic resin impregnated plywood. This had been used as an insulator in a power transformer. I am willing to supply a piece of suitable material for the insulated spacer. Unfortunately, the number of pieces that I can provide is limited so it will be a case of first come first served. If you require a piece of resin bonded plywood insulating material please telephone 01572-77046 or e-mail **dickstephn@aol.com** to find if I have any left. A piece will cost you just £1 to cover the cost of the postage and packing. If you can't find anything else suitable, you could make a piece out of layers of brown Formica glued together with epoxy resin.

The stand for the contacts is fabricated rather than made out of a single piece of brass. This simplifies the machining of the bracket to which the track rods are attached, which has a rather complicated shape. Don't forget to position the holes for the track rods and screws carefully so that there is a seamless join between the contact assembly and the track rods. The track rods insert into 2.5mm dia. holes drilled 2mm deep in the front of the track block. The support base and track block are joined to the support using Loctite High Strength Retainer. Assemble the contacts on the stand.

●*To be continued.*

Figure 43
Track Block, Contact Support, Base and Insulator,