A FERRIS WHEEL CLOCK

Richard Stephen
explains how to position the lifting tube and contact assembly on the base plate.

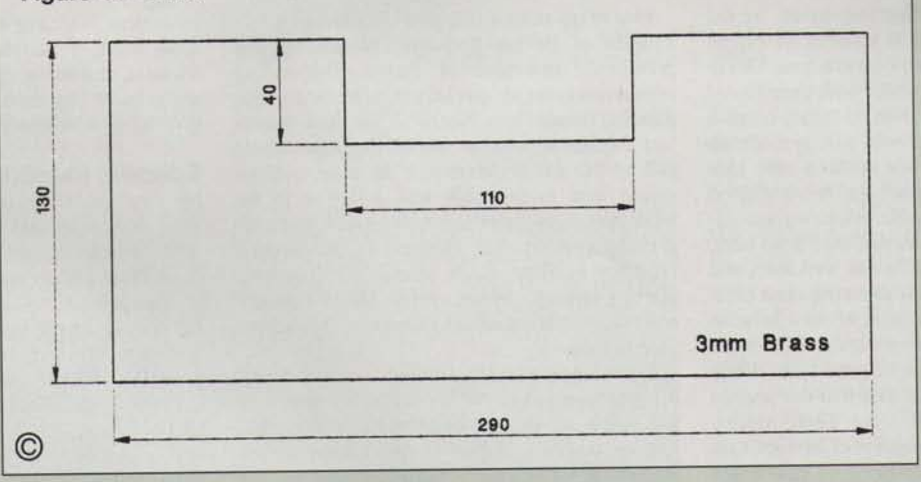
●*Part XI continued from page 592 (M.E. 4184, 13 December 2002)*

The brass base plate for the clock can now be prepared; it is shown in **fig 44**. Looking back at part VII of this series (p291, *M.E.* 4178, 20 September 2002) I note that the recess sizes in the feet of the wooden test base (fig 27) were given incorrectly. All is not lost however as some quick work with a chisel or a milling cutter will soon open up the recesses to the required size and allow the base to sit in them as intended. Sorry about the mix up! The location of the movement on the base plate can be gauged from the position adopted on the wooden test base and the holes for the fixing screws drilled accordingly or marked out using the little 'spurs' prepared earlier.

I have not provided any detailed drawings for the positioning of the lifting tube and the contact assembly. The precise point that the ball rolls off the Ferris wheel determines the position of the contact assembly. It is unlikely that a Ferris wheel made by a reader will drop a ball at exactly the same position as the one that I made for my clock, even if the movement is positioned as mine.

The contact assembly and quarter hour strike mechanism attached to the front time bar.

Figure 44 - Base



Attach the assembled movement, excluding the pallets, to the base plate and secure the base plate onto the test base you made earlier. Using a spirit level, check that the surface of the base plate is level. Place a ball in one of the slots and allow the wheel to rotate very slowly until the ball just rolls out of the slot. Stop the wheel at this position. Now rest an engineer's square on the base plate with the blade of the square just touching the periphery of the slot the ball rolled out of. Mark the position of the blade on the base plate but do not use a scriber, as this will require the expenditure of significant amounts of elbow grease to remove the mark when polishing the base plate! Repeat the above for all the slots in the wheel. If the drop off positions are all the same (± 0.5mm) you can proceed, if not you will need to adjust the profile of the wheel using a fine file until they are.

Measure the height from the base to the point on the wheel where the ball drops off ('h'mm) and make a note of it. This measurement is required later. Now move the square 12mm away from the drop off line with the blade midway between the sides of the wheel. Place a ball in a slot and allow the wheel to rotate until the ball drops off. When it drops off, the ball should just touch the edge of the blade. If the ball does not just touch the blade of the square, reposition it until it does.

Carefully mark this position on the base, which we will refer to as 'D'. Draw a horizontal line on the side of the contact assembly you have just made 'h'mm from the base. The point where this line meets the edge of the contact we shall call 'A'. Measure the distance ('d'mm) between the point 'A' and the central axis of the stand. We are now able to determine the position of the 6mm hole in the base plate for the locating peg at the bottom of the contact stand. Measure the distance ('b'mm) from the front long edge of the base plate to the point midway between the two sides of the wheel. Draw a line on the base plate this distance parallel with the long side. Locate the point 'D' on this line and mark a point ('d'mm) from 'D' on the line. This is the position of the 6mm hole for the locating peg at the base of the contact stand. Before drilling this hole repeat the above and check the position very carefully. *If the hole is drilled incorrectly the base plate will be scrap.*

Fit the contacts on the stand into the hole in the base and line up the contacts with the wheel. Place a ball in one of the slots and check that it drops off and runs smoothly down. If you have an electrical test meter, check that the ball closes the circuit as it runs down between the two contacts. When you are satisfied with the position, drill and tap the three 2mm dia. screw holes that are used to secure the contact assembly to the base.

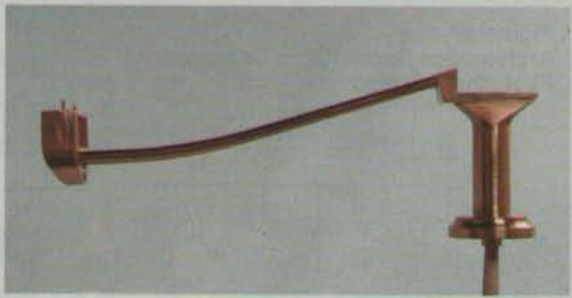
The lifting tube can now be attached to the base. The position of the lifting tube is not as critical as that of the contacts. The centre of the lifting tube is situated 'b'mm from the front long edge of the base and approximately 35mm from the side edge. The entrance for the balls in the lifting tube has to line up with the contact assembly.

Drill and ream a 5mm dia. hole in the base plate. Fit the Archimedes screw on its arbor in the lifting tube. The arbor fitted in the 5mm hole will make it a lot easier to orientate the lifting tube for drilling the holes for the screws. Drill and tap the three holes for the 2.5mm dia. screws that secure the lifting tube to the base. The 5mm dia. hole in the base is now bored out to a diameter of 22mm.

The track rods that connect the contact assembly to the lifting tube should be fitted now. The track for my clock is illustrated in the photographs. The track rods are not straight but are slightly curved to provide clearance for the balls to run under the bottom pillar of the movement. The curvature of the track rods and their length depends on the relative positions of the contact assembly and the lifting tube. As a result I am afraid that fitting the track in place is a matter of trial and error. I used a piece of wire bent to the approximate shape to estimate the length and then added on 5mm. I gradually reduced the length until I got the track to fit between the lifting tube and the contact assembly.

Reassemble everything and check that the balls drop off and roll smoothly down the track into the lifting tube.

Above: a view of the quarter hour strike mechanism reflected in the highly polished brass base plate of the clock. Note the snug fit of the bell under the track.



Top right: the contact support and entrance track for the prototype clock. This photo gives some idea of the curve required in the track rods.

Right: the Archimedes' screw looking from below. The edge chamfers and the hooked shape of the leading edge of the screw are apparent.

Finishing the Archimedes screw and getting the balls to lift

The thread of the Archimedes screw needs to be filed to shape before it will work. The pitch of the thread was made to be equal to the diameter of the balls and the depth of the thread 0.50mm greater than the radius. As a consequence, the separation between the threads is less than the diameter of a ball (the separation is 14.2mm, the pitch 15mm minus the thickness of the thread, 0.80mm). The photograph shows the profile of the thread from my clock, which will give you an indication of how to proceed. Again, it is a matter of trial and error.

As the motor has not been fitted, the screw will have to be turned by hand. To make it easier to turn the arbor of the screw with your fingers, knurl a short length of 20mm dia. bar and secure it to the screw arbor with a grub screw. Begin the shaping by chamfering the underside of the top of the thread. Carefully file the bottom of the thread until a ball fully enters the screw and rests against the shaft. The bottom of the thread should be filed to the hook shape shown. This ensures that as the screw rotates, the initial contact of the thread against a ball pushes the ball vertically. If the thread initially contacts a ball slightly on the side, the thread will push the ball outwards causing it to jam against the side of the lifting tube.

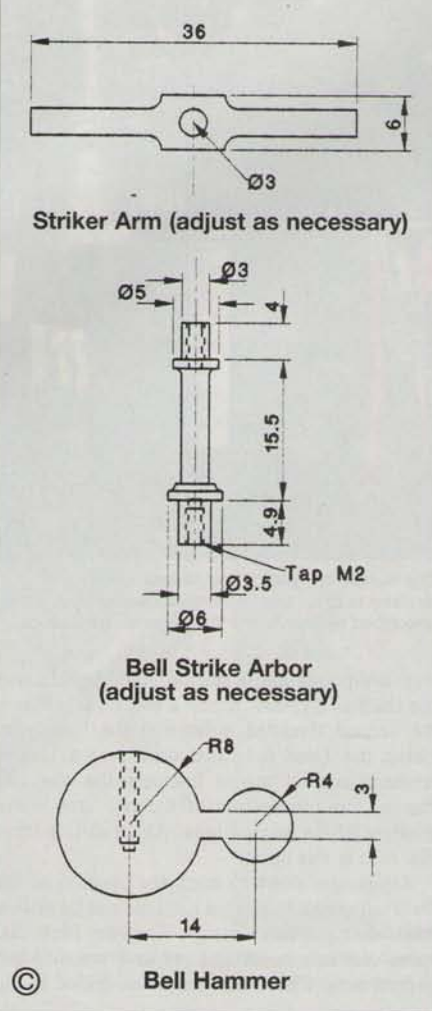
The four balls on the track provide an adequate force to hold the ball resting on the platform in a position to be cleanly picked up by the thread. Turning the screw should pick up the ball on the platform cleanly, lift it past the non-return catch and allow the catch to drop back down leaving the ball in the vertical track. Finally check that the lift works with the vertical track filled with balls. If you do not get the screw to work initially you will have to persevere until you do get it to work. It took me some time before I got mine to work. It now works perfectly and has done so for many months.

Finishing the track

All that remains to be done is to complete that part of the track down which the balls roll onto the wheel. Figure 42 (see Part X in this series, p591, *M.E.* 4184, 13 December 2002) shows this section of the track. This section of track is held in place by two grub screws and supported by the curved section silver-soldered to the front vertical track rod and secured with a screw passing through the bracket. The two track rods are silver-soldered to the bracket.

Like many of the parts of the lifting mechanism, this section of track has to be made to fit. A close examination of the front of the track shows that the front of the two rods have been chamfered. The clearance between the front of the track and the wheel should be as small as possible. The overall height of the vertical and delivery track should be such that the balls roll smoothly from the track onto the wheel. The vertical track rods were initially made a little overlength; these will have to be reduced in length to make the delivery from track to wheel smooth.

Figure 45



Quarter hour strike

When a ball drops off the Ferris wheel every 15 minutes, I felt that in addition to just producing a clatter, the drop of the ball might as well strike a bell. The bell I used was one I picked up years ago among some horological odd and ends. The size of bell I used is 50mm diameter by 20mm high. Any other bell that will fit under the track will do equally well.

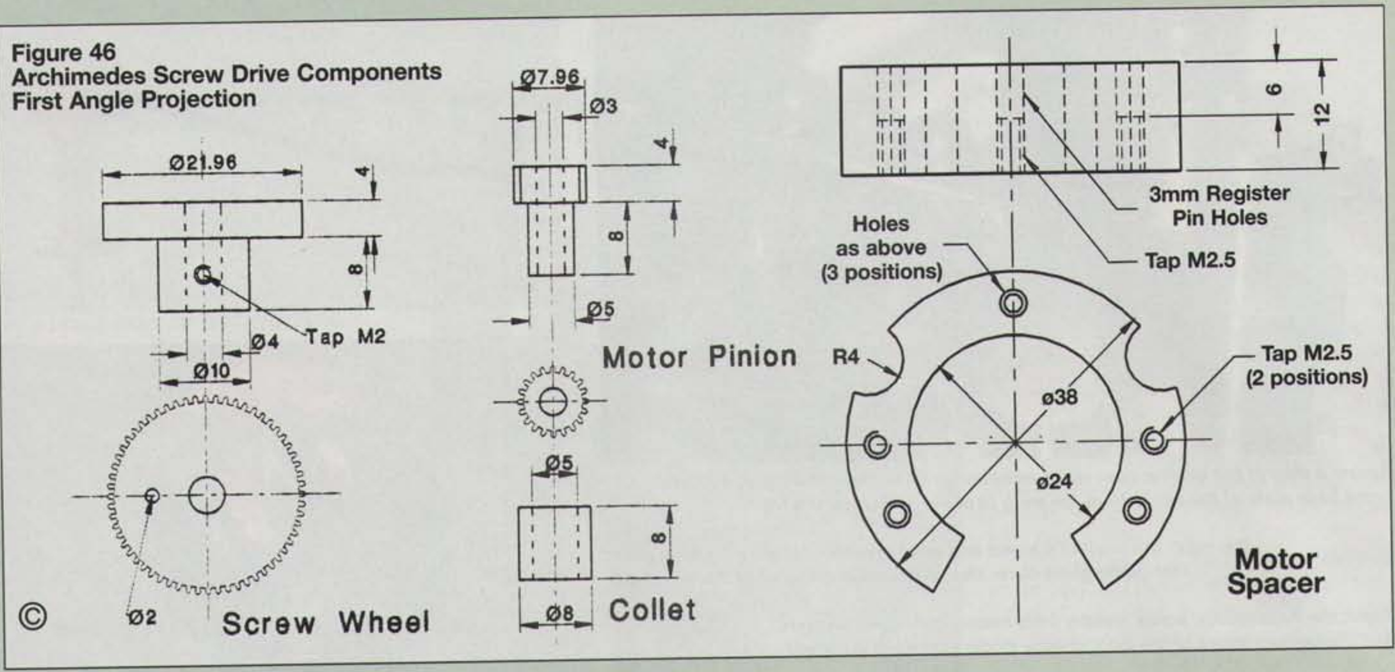
The details and dimensions of the striking mechanism are shown in **fig 45**. The position of the hole in the front time bar for attaching the strike must be arranged to suit your bell.

Motor drive

The motor I used for driving the ball lift is a Buhler 12 volt unit with an integral gearbox, geared down to 60rpm. The motor spindle is fitted with a 20 tooth pinion wheel which drives a 60 tooth wheel fixed to the arbor of the screw giving a further speed reduction to 20rpm. The motor is powered by four alkaline D cells connected in series to provide 6 volts. At this reduced voltage, the motor runs at approximately 10rpm. At this drive voltage the torque delivered to the screw is more than adequate to lift a column of thirteen 15mm dia. steel balls. The Buhler motor is available from Motors Direct as specified in Part I of this series (p177, *M.E.* 4186, 5 April 2002). The Buhler motor has proved to be an excellent choice for the following reasons:

1: There is no significant over-run when the motor is turned off.
2: Power consumption is such that the clock runs for at least 4 months on one set of alkaline D cells.
3: Motor and gearbox are almost silent.
4: At £7.50, cost is very reasonable.
5: The 6 volt supply for the motor also supplies the electronic control board.

My latest information is that the actual motor which I used is no longer available from Motors Direct but that a suitable alternative is offered. ▶



The replacement has a different output speed, which can be accommodated by modifying the gear ratio between the motor and the Archimedes screw. The design is flexible so there is no reason why another type of motor could not be used. It is simply a case of the appropriate modifications being made for mounting the motor. Readers who have come this far with the clock should have no difficulty sorting out the necessary details.

Mounting the motor

My motor is mounted on a piece of 3mm brass sheet 50 x 80mm (x, y). Begin by drilling the holes to secure the motor to the piece of brass sheet. Start by drilling a 3mm hole, the diameter of the motor shaft, at the position x = 25mm, y = 35mm. Positioning the holes for the screws that attach the Buhler motor to the mounting plate is rather awkward as the screw holes are not symmetrically placed with respect to the shaft.

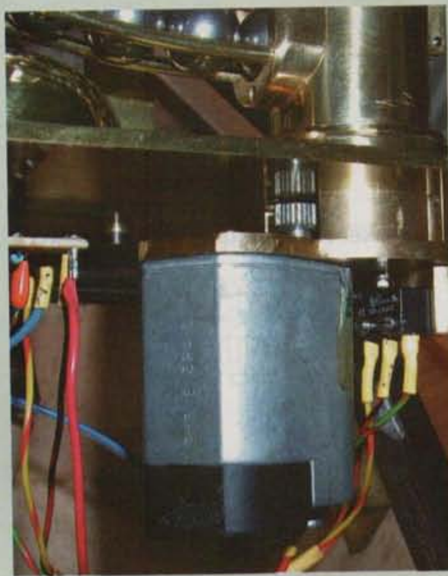
My method was as follows. The motor was held in the vice in the milling machine with the long side of the casing parallel with the x-axis of the mill. Using the centring microscope, the centre of the motor shaft was picked up and the x and y digital read-outs zeroed at this position. Using the microscope, the co-ordinates of the three holes relative to the centre of the shaft were measured. The mounting plate was then clamped to the bed of the mill with the long edge of the plate parallel to the x-axis. The centre of the hole drilled for the shaft was then located using the microscope and the digital read-outs zeroed. The three 3mm dia. holes for the screws were then drilled and countersunk at the previously measured co-ordinate positions.

Alternatively, you could adopt the method used to drill the holes to screw the movement to the wooden test base. You will need two short lengths of 3mm steel screwed rod (the screws for mounting the motor are 3mm). Holding the screw rod in a collet or 3-jaw chuck, turn a sharp point on the end of each piece. Screw one of the pieces into one of the threaded holes in the motor and using the motor shaft as a centre, scribe an arc. The screw hole will lie on this arc. Measure the distance of the centre of the hole from the long side of the motor casing. Adding 2mm to this measurement mark a point on the arc this distance from the long edge of the plate. Drill a 1mm dia. hole at this point. Now screw one of the threaded points into a second hole. Again using the shaft as a centre, scribe a second arc. Screw the second threaded point into the first hole. Using the 1mm hole just drilled as a centre, scribe a second arc to intersect the one just drawn. The intersection of the two arcs is the position of the second hole. Again drill a 1mm dia. hole at this point.

Repeat the above to mark the position of the third mounting hole. This last hole can be drilled 3mm dia. and countersunk. The two 1mm dia. holes can now be drilled out to 3mm dia. and countersunk. Check that the holes drilled in the plate line up with the holes in the motor casing and that the screws tighten up easily.

Archimedes' Screw Drive Gears

	Module	No. of teeth	Pitch Circle Dia. (mm)	Full Dia. (mm)
Motor Pinion	0.35	20	7.0	7.96
Screw wheel	0.35	60	21.0	21.96



The Buhler 12V motor and its mounting as devised to drive the Archimedes screw and described by the Author for his prototype clock.

Motor pinion and Archimedes screw wheel

Details of the motor pinion and screw wheel are given in **fig 46** and the adjacent table. The motor pinion is made from a length of EN1A mild steel rod and can be cut quite satisfactorily using a wheel cutter. There is no need to harden and temper the pinion. The collet for the pinion is also made from a piece of EN1A mild steel. I fitted a collet which made it easier to drill and tap the thread for the 2mm dia. grub screw. The wheel is best made from a length of 25mm dia. brass bar. The collet can then be made as an integral part of the wheel.

Depth the wheel and pinion and mark the position of the screw arbor on the motor mount. Drill and ream a 2mm dia. hole. With the 2mm dia. hole as centre, mark the positions of three 1.5mm dia. register pins and two 2.5mm dia. screws on the circumference of a circle having a 15.5mm radius. Drill the holes for the register pins and the screws.

Spacer

The motor should be mounted 10mm below the base plate of the clock to provide space for the motor pinion and Archimedes screw wheel. Figure 46 illustrates the details and dimensions of the required spacer. The spacer is attached to the base plate by three 2.5mm dia. screws positioned as shown in the drawing.

The spacer is made from a 12mm length of 38mm dia. (1.5in.) brass bar. Begin by facing off both ends of the length of bar. Reduce one end for a length of 2mm to 22mm, the diameter of the hole bored in the base plate. Fit the 22mm dia. end into the hole in the base plate and mark the positions of the 2.5mm dia. screws that attach the spacer to the base. Drill and tap the holes for the screws. The holes must be no deeper than 6mm.

The holes for the motor mount register pins will be drilled in the same positions on the other side of the spacer. The spacer is now bored out to 22mm, the diameter of the hole in the base plate. Access for the screws that attach the lifting tube to the base plate are cut with a 6mm slot drill.

●*To be continued.*