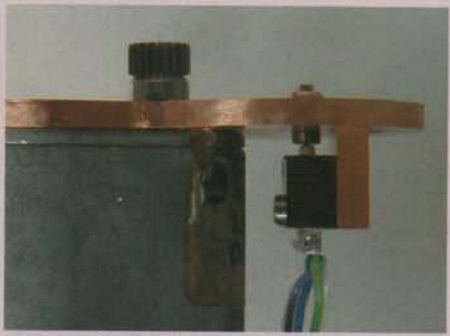
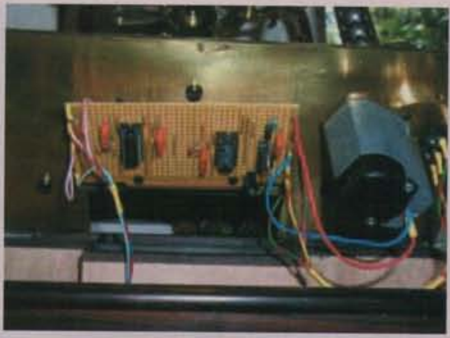


*The micro switch and operating plunger mounted on the Archimedes screw drive motor mounting plate.*

*A view of the electronic control board. Although this may seem daunting for some builders, its construction is really quite simple.*



*This view of the motor control board shows how it is mounted in relation to the Archimedes screw drive motor which it controls.*

# A FERRIS WHEEL CLOCK

**Richard Stephen**

fits the motor and micro-switch and builds the control circuit.

●*Part XII continued from page 24 (M.E. 4186, 10 January 2003)*

Attach the spacer to the base and assemble the Archimedes screw in the lifting tube, only fitting the cover at this time. The ball races should also be fitted. Attach the lifting tube to the base. At this stage the screw arbor will extend below the spacer. The arbor should be turned down to fit into the 2mm dia. hole in the motor mount. The 2mm dia. end of the arbor is not necessary as a pivot, the two ball races are more than adequate support for the screw. However, it does provide a measure of extra support and assists in the positioning of the motor and depthing of the wheel and pinion.

Disassemble the arbor; you will not need to unscrew the lifting tube to do this. Reduce the end of the arbor to 2mm diameter. The clearance between the shoulder and the surface of the motor mount should be about 0.25mm. The arbor should also be reduced to 3.5mm dia. for a length of 11.75mm to fit the screw wheel. This gives a distance between the screw wheel and the motor mount of 3.5mm. Fit the wheel onto the arbor and secure it with a 2mm grub screw. To ensure that the wheel does not slip, a 1mm dia. hole is drilled into the arbor, its position being marked by filing a sharp point on the end of the grub screw mounted in the lathe. Slip the wheel onto the arbor and tighten the grub screw against the arbor marking the position of the 1mm hole. Drill the hole, reduce the end of the grub screw to 1mm and check that it locates in the hole.

Re-assemble the screw on its arbor in the lifting tube. Attach the wheel and secure it with the grub screw. Attach the pinion to the shaft of the motor and secure it in place with the grub screw. Position the motor mount on the spacer using the 2mm dia. end of the arbor to line it up. Clamp it in place. Before drilling the holes for the register pins it is as well to check that the wheel and pinion are meshing properly. Unfortunately it is impossible to see the wheels or to turn the Archimedes screw by hand. Connect the leads of the motor to a 6V battery and check that the screw turns smoothly with little noise. If it is noisy the depthing of the wheel and pinion will have to be altered. Unfortunately this means either making the motor mount again or drilling out the 2mm hole to 4mm diameter, bushing it and re-depthing.

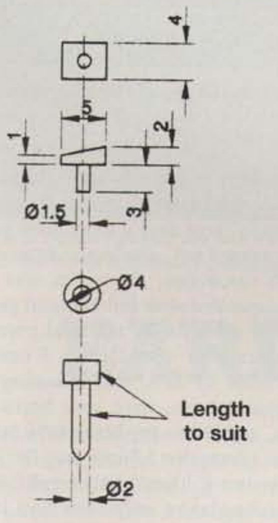



**Figure 47 - Microswitch Ramp and Plunger**

©

If the screw turns nice and smoothly mark the positions of the register pin holes and the holes for the two 2.5mm screws. To drill the holes for the register pins and the screws in the spacer you will have to take everything apart. Fit the register pins into the motor mount and tap the holes for the 2.5mm dia. screws. The motor mount, still in its original rectangular shape, can now be shaped to fit neatly around the motor and the spacer.

The time has now come to test the entire ball re-cycling assembly under power. Assemble the lifting tube and Archimedes screw, contacts, entrance track, vertical track, delivery track and motor on the base plate on the temporary base. Place four balls on the entrance track. Connect the motor to a 6V battery. Connect the blue lead to the negative terminal of the battery and touch the red lead against the positive. The screw should turn clockwise, pick up a ball and deposit it in the vertical track. Detach the red lead and add another ball to the entrance track. Lift up a second ball. Repeat until the vertical track is filled and the balls roll down the delivery track.

## Fitting the 'off' micro-switch

The final mechanical component to be fitted is the micro-switch that turns off the motor after one revolution of the Archimedes screw. Suitable micro-switches are available from any good supplier of electronic components. One of the best is RS Components. I used the basic type V4 but any other similar micro-switch will do just as well. The photograph illustrates the mounting of the micro-switch. The switch is actuated by a glass hard steel ramp attached to the face of the Archimedes' screw wheel. As the wheel rotates a plunger in contact with the switch button is raised by the ramp closing the contact. The wheel continues to rotate until the plunger drops off the end of the ramp at which point the control board cuts off the power to the motor.

Remove the motor from its mounting. Begin by attaching the brass bracket on which the switch is mounted onto the motor base. When you buy the switch, be sure to get a copy of the dimensions and mounting details for it from the supplier. Before you attach the bracket ensure that the button on the switch will line up with the hole in the screw wheel for the actuating ramp. Drill and tap the holes in the bracket to attach the switch. Locate and mark the point on the motor base directly below the button. Drill a 3mm hole through the motor base for the plunger sleeve which is made from a scrap of brass rod and fixed into the 3mm hole in the base with Loctite. The plunger is made from a length of 4mm silver-steel rod. The ramp is made from a piece of 6mm silver-steel rod, glass hardened and polished.

Fix the motor base in position on the spacer. Mark the position of the hole for the ramp in the screw wheel using a short piece of 2mm steel rod, with a sharp point, fitted into the 2mm hole in the sleeve. Drill the 2mm hole in the wheel and fix the ramp in position using Loctite. Fix the whole switch assembly in place. The top of the plunger should just be in contact with the button. Adjust the length of the plunger so that as the wheel rotates the plunger is raised just enough to close the contacts and allow them to open again when the plunger drops off the top of the ramp. The end of the plunger in contact with the ramp is rounded and polished. The plunger can now be heated to a cherry red and quenched, polished and left glass hard.

This completes all the mechanical parts of the clock. All that remains is to make the electronic control board and a nice wooden base on which to mount the whole clock.

## Electronic control board

**Figure 48** illustrates the circuit diagram of the board used to control the motor. The advantage of using electronic motor control is that no levers are required to control the switching. This removes clutter and I feel improves the overall appearance of the clock. Readers who have little

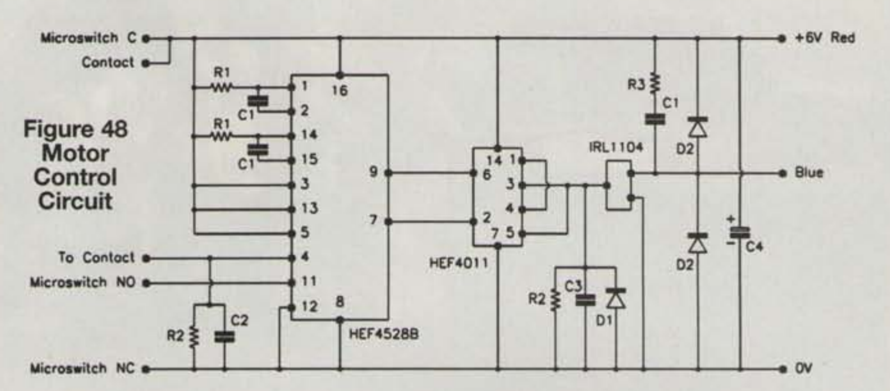



**Figure 48 Motor Control Circuit**

R1 = 100k; R2 = 10K; R3 = 100R; C1 = 0.1µF (polyester); C2 = 0.1µF (ceramic); C3 = 0.01µF (polyester) C4 = 22µF (electrolytic) D1 = 1N4148; D2 = SBYV 27-200

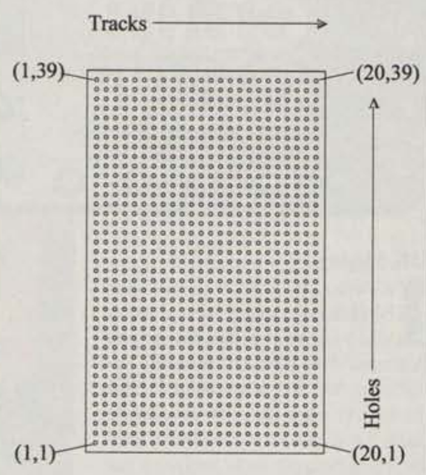



**Figure 49 - Veroboard hole numbering**

or no experience of electronics may begin to worry at this point. These readers can be assured that no knowledge of electronics is required to build the control board. Construction will be done entirely by numbers. The materials required are shown in the accompanying table and, since they are not costly, a few spares would not go amiss.

## Assembling the board

The piece of Vero board used for the control board has 20 tracks and 40 holes along each track. The position of the various components to be soldered to the board will be denoted by the hole number followed by the track number with the board viewed from the component side (not the side with the copper tracks). The component positions are numbered beginning from the bottom left hand corner (see fig 49). Thus a resistor fitted at (10,12; 10,16) has to be soldered to hole 10 on track 12 and to hole 10 on track 16. Check the various connections against the circuit diagram (fig 48) as well as the functional data for each chip before you solder each component in place.

Begin assembling the board by soldering the two DIL sockets in place:

1: 16 pin: (31,14; 31,7; 27,7; 27,7)
(pins 1, 8, 9, 16)
2: 14 pin: (14,12; 14.6; 11,6; 11,12)
(pins 1, 7, 8, 14)

Before soldering the sockets in place, use the track cutter to cut the tracks between the pins of the sockets. To cut a track, place the point of the drill in the hole where the track is to be cut and twist. After cutting check carefully that no whiskers of track remain to cause a short circuit.

Insert and solder Vero board pins at the following points: (1,1; 1,5; 1,10; 1,18; 1,20; 40,1; 40,11; 40,18; 40,20).

A number of links will be required. Links are best made using tinned copper wire which has first been stretched to straighten it, each link being made to exactly suit the distance to be spanned. By this means, the job will be a lot easier, much neater and far easier to check. I find that a piece of masking tape is helpful to hold the link in place against the surface of the board when soldering. Link the following circuit points:

(5,1; 5,9), (8,11; 8,14), (9,4; 9,18), (10,12; 10,18), (15,1; 15,6), (15,9; 15,12), (16,8; 16,10), (17,10; 17,14), (22,6; 22,11), (26,5; 26,9), (26,11; 26,14), (27,1; 27,10), (27,14; 27,18), (32,1; 32,7), (32,12; 32,18), (33,6; 33,8), (33,10; 33,12), (39,18; 39,20).

Link capacitors between the following points:

Metallised polyester:
0.1µF: (3,10; 3,13), (24,12; 24,13), (34,13; 34,14).
0.01µF: (16,6;16,8).

**Electronic control board components**

1: 0.1in. pitch Vero board 2½ x 4in. with the tracks running along the length of the board (i.e. parallel with the long side).
2: DIL socket: 1 x 16 pin.
3: DIL socket: 1 x 14 pin.
4: Vero board pins: 1 pack.
5: 22swg tinned copper wire: 5 metres.
6: 1.2mm pvc coated stranded tinned copper wire: 1 metre each red, black, green and yellow.
7: Heat shrink tube: short lengths of 2.5 and 5mm.
8: Resistors (0.5W): 2 x 10k ; 2 x 100k ; 1 x 100R.
9: Capacitors: 3 x 0.1µF, 1 x 0.1µF (polyester); 1 x 0.1µF (ceramic), 1 x 22µF (electrolytic)
10: Diode: 1 x IN4148, 2 x SBYV 27-200.
11: Dual mono-stable multi-vibrator: 1 x HEF4528B .
12: CMOS gate: HEF4011.
13: Power MOSFET: 1 x IRL 1104
14: 4-cell battery holder to suit D-size cells.
15: Soldering iron and solder suitable for electronic circuit assembly.
16: Snipe nose pliers and flush cut wire cutters.
17: Veroboard track cutter or 4mm twist drill in a handle.
18: Electrical test meter (very handy if you happen to have one).

Ceramic
0.1µF: (35,7; 35,11).
Electrolytic
22µF: (-ve 8,1; +ve8,4)

Link resistors between the following points:

100R: (4,13; 4,18)
1k: (34,7; 34,11)
10k: (17,6; 17,10).
100k: (25,12; 25,18), (33,13; 33,18).

Solder the diodes between the following points. Consult the circuit diagram to ensure you solder the diodes the correct way round. To assist in this, unlike the co-ordinates of the rest of the components, the co-ordinates of the end with the bar are given first:

SBYV27-200: (4,10; 4,1) (5,18; 5,10).
IN4148: (18,10; 18,6).

Solder the power MOSFET at the following points:

(6,9; 6,10; 6,11) (pins 3, 2, 1 respectively)

Finally cut the tracks at the following points:

(8,6), (8,7), (8,8), (8,9), (8,10), (8,11), (8,12), (11,4), (21,6), (21,8), (21,9), (21,10), (23,11), (23,12), (23,13), (23,14).

That completes all the connections. You should now check very carefully the connections on the board against the schematic circuit diagram (fig 48). Check the underside of the board that all the solder joints are sound and that there are no short circuits.

The board should now be tested. If you have an oscilloscope available test the board with this first. Connect a spare microswitch to the board using some of the 1.2mm PVC wire. The microswitch has three terminals NO, NC and C. With the terminals uppermost connect the left one (NC) to 0V pin (1,1), the centre one (NO) to pin (1,5) and the right one (C) to +6V pin (1,18). When the switch is closed the $i_{oB}$ input goes high (+6V) and only triggers monostable B on a high-low transition. This action turns off the motor. The ball contacts will be connected to pin (40,11) and to +6V pin (40,18). For the moment don't connect the contacts, rather two short lengths of PVC covered wire with the free ends bared. When a ball closes the contacts or you touch the two free ends, the $i_{1A}$ input of the monostable A goes low-high. This will trigger monostable A and turn on the motor. Connect the terminals of the battery pack to the remaining +6V and 0V pins. Insert the two ICs into their respective sockets. The pin to the left of the notch on top of the IC is pin 1.

To test the circuit, clip the earth of the 'scope to one of the 0V pins and hold the flying lead of the 'scope against pin 7 of the HEF4528. The 'scope should register +6V. Briefly touch the two bare ends of the 'contacts'. This should produce a brief negative going pulse. Now hold the flying lead of the 'scope against pin 9 of the HEF4528. The 'scope should register +6V. Close the microswitch; nothing should happen, releasing the switch should produce a brief negative going pulse. Now hold the flying lead of the 'scope against pin 3 of the HEF4011. Briefly touch the bare ends of the 'contacts'. The 'scope beam should jump from 0V to 6V and remain there. Close the microswitch and release it. The 'scope beam should drop back to 0V as soon as the switch is released. The board can now be tested with the motor connected. Connect the blue lead to circuit board pin (1,10) and the red lead to pin (1,18) (+6V). Briefly touch the bare ends of the 'contacts'. The motor should begin to rotate anti-clockwise. Closing and releasing the microswitch should instantly stop the motor.

The control board is fixed to the underside of the brass base plate by two screws. These screw into a piece of Tufnol or other insulating material attached (glued with Araldite) to the brass base.

This completes the mechanical and electronic aspects of the clock. All that remains is to make the base and test the clock before you dismantle it and polish all the parts.

●*To be continued*