An Automaton Harmonium Player

Inspired by an article in the Summer 2013 “Music Box’ by Gordon Bartlet, titled “A pair of mechanical music novelties” I decided that I wanted to design and build an automaton organette Harmonium player. Having a Seraphone organette with a number of music rolls by Schmidt I decided to use the same arrangement so that I could use the same rolls on the automaton. In order to leave the upper surface of the organette clear for the automaton, I settled on using player piano style pouch valves for the pneumatics. These have the advantage of being able to have the tracker bar and roll mechanism remote from the valve stack and also easily allow the roll mechanism to be mounted vertically at the back of the instrument.

In terms of the movements of the automaton, I decided that the player would obviously pedal the Harmonium (or in reality, the Harmonium pedals would move her feet/legs), her arms would move to pass her hands over the keyboard and she would tilt her head down to look at the music stand when playing starts. I also wanted the keys to move, but choosing a scale of 1:4 for the player meant that it was impractical to articulate the fingers so I settled upon the idea of placing tiny Neodymium magnets in the fingers and similar magnets in some of the keys with like poles facing together. In principle, this would cause the magnets to repel as the hand moved over the keyboard, depressing the keys. To improve the movement of the keys further, a two lobe cam rotating over the back of the key within the Harmonium case, would repeatedly raise the key by depressing the back arm whilst the hands were still, giving a repeating motion to the key. I also decided that I would like to add a dog lying on the floor behind the stool. The dog’s eyes to open when playing starts and then wagging it’s tail during the performance.

Figure 1 shows the three mahogany sections that were machined to make up the valve stack, on the left is the pouch block, the middle shows the underside of the valve block and on the right is the underside of the reed block.

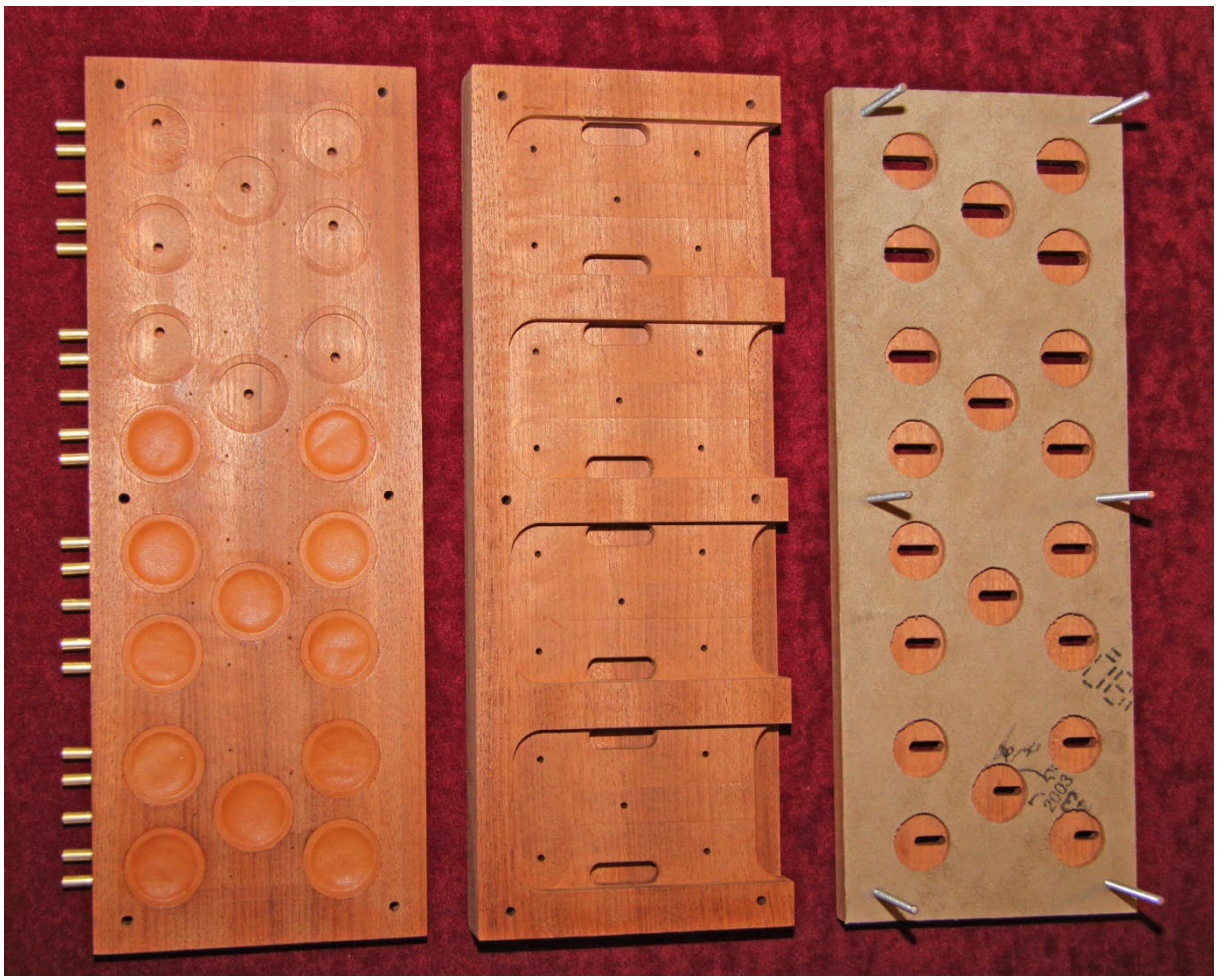

Fig. 1

I chose to make the valves out of "Delrin" acetyl resin and also the valve seats, which were bonded into the top of the mahogany valve block. The assembly of the pouch and valve blocks is shown in Figure 2.

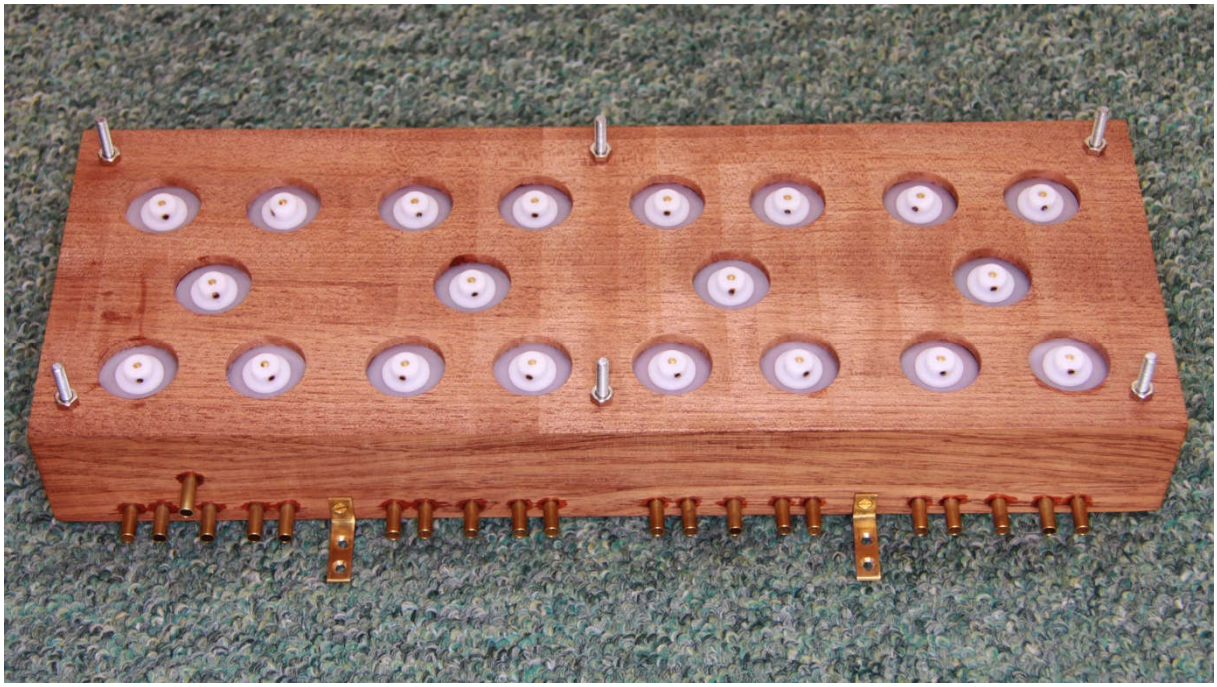

Fig. 2

In addition to the 20 tubes which connect the underside of the pouches to the tracker bar, another tube provides a take off from the vacuum reservoir to operate pneumatics in the Harmonium player's torso and the dog's body.

A salvaged set of high quality brass Harmonium reeds were obtained from a seller in the USA via a well-known Internet auction site and a cutter made to machine the 'T' slots in the mahogany reed block to take the slot in reeds. The finished reed block can be seen in Figure 3.

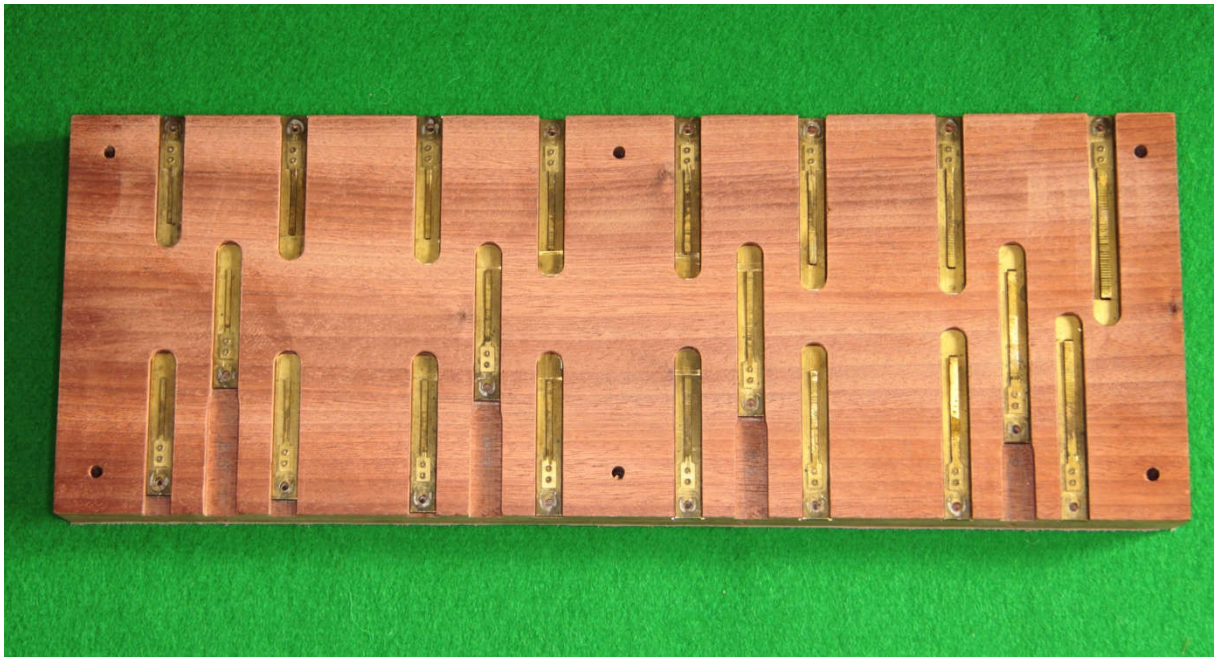

Fig. 3

The design of the exhausters and vacuum reservoir were taken directly from my Seraphone Organette. The design comprises four exhausters feeding the reservoir and the only difference between the Seraphone and my automaton is the incorporation of precision ball races for the five main crankshaft bearings and also ball races in each end of the two connecting rods which attach to the exhausters as shown in Figure 4.

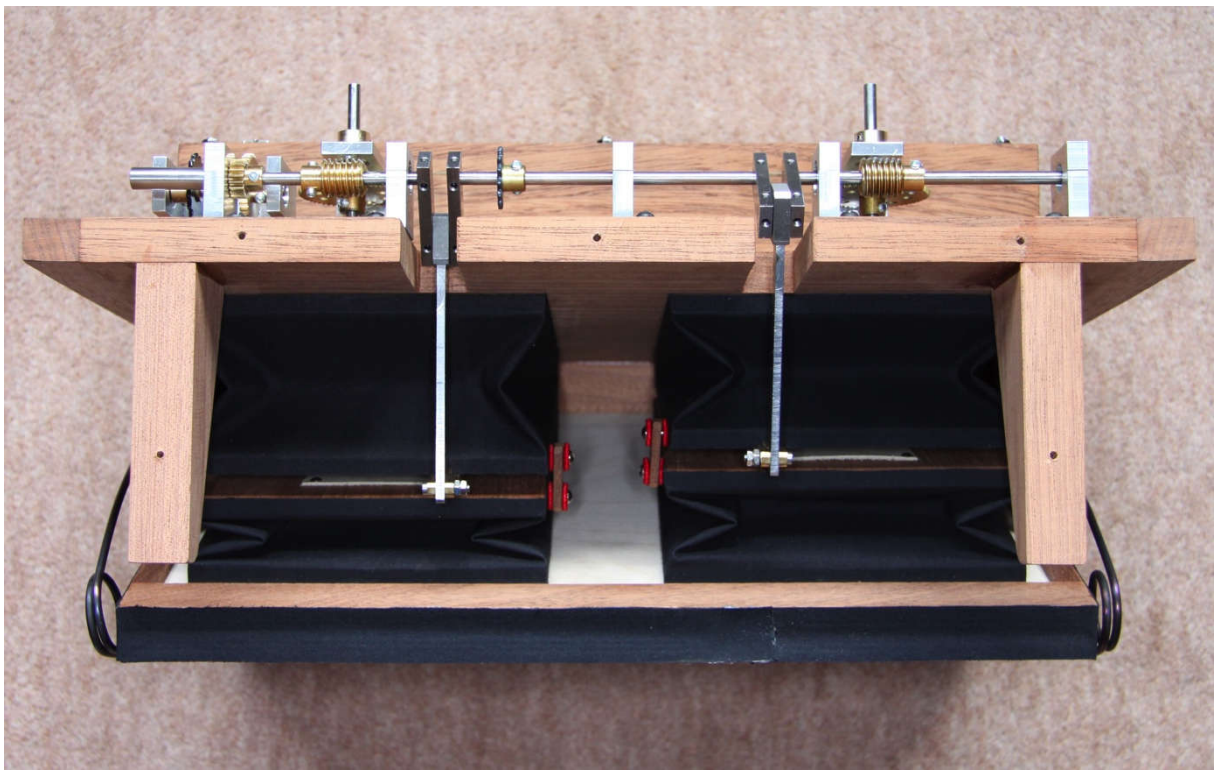

Fig. 4

The drive for the control rods that rotate the arms over the keyboard are taken from the main crankshaft via a pair of worms and wheels. All the gear and chain wheels are "Meccano" but with the bore opened out to 3/16" diameter, as I happened to have a large quantity of 3/16" precision ball races in stock. The worm for the left hand is a standard "Meccano" item, however it is necessary to rotate the cam for the right hand in the opposite direction so that the cam follower is pulled over the cam profile, rather than pushed, so it was necessary to screw-cut a similar worm but with a left hand helix for the right hand. The gears that mesh with the two worms are of 60 and 57 teeth so that the arm movements do not simply repeat each revolution. The cam followers are terminated in miniature ball races to reduce friction between the follower and cam profile.

The tracker bar was machined from brass and mounted on the back panel along with the roll drive mechanism, again using "Meccano" chain wheels, sprockets and gears. The roll holder has a light friction clutch (at the right hand side in the photo) to provide tension for the roll during playing. A custom made dog clutch provides the necessary "Play / Rewind" facility. Figure 5 shows the completed arrangement.

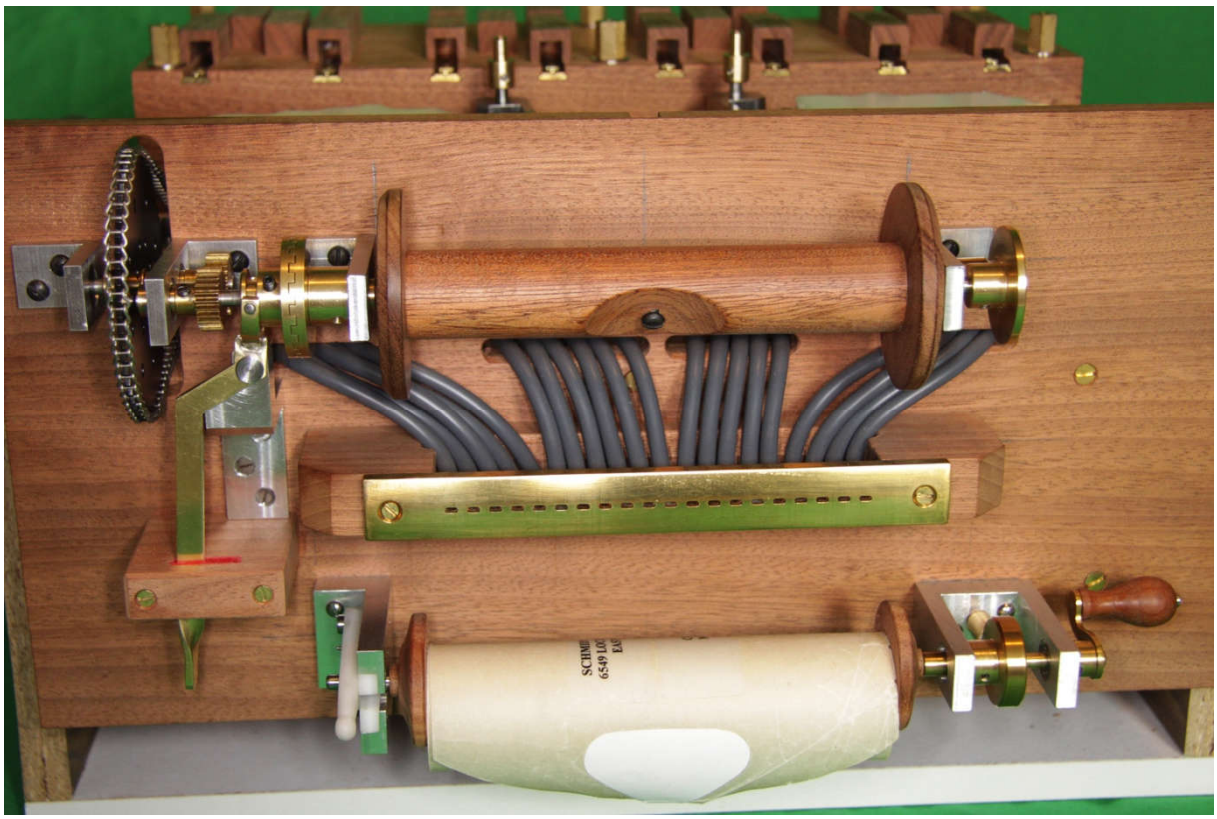

Fig. 5

The top view in Figure 6 shows the arm cam arrangement. The two small sprockets in the middle of the crankshaft and the right hand end are for the drive chain take off for the Harmonium pedals and the drive for the dog's tail wag mechanism. The drive for the Harmonium pedals turns another crankshaft in the Harmonium which gives the pedals the correct angular movement and a further chain drive from this crankshaft turns the two lobe cam which operates the keyboard repeat mechanism.

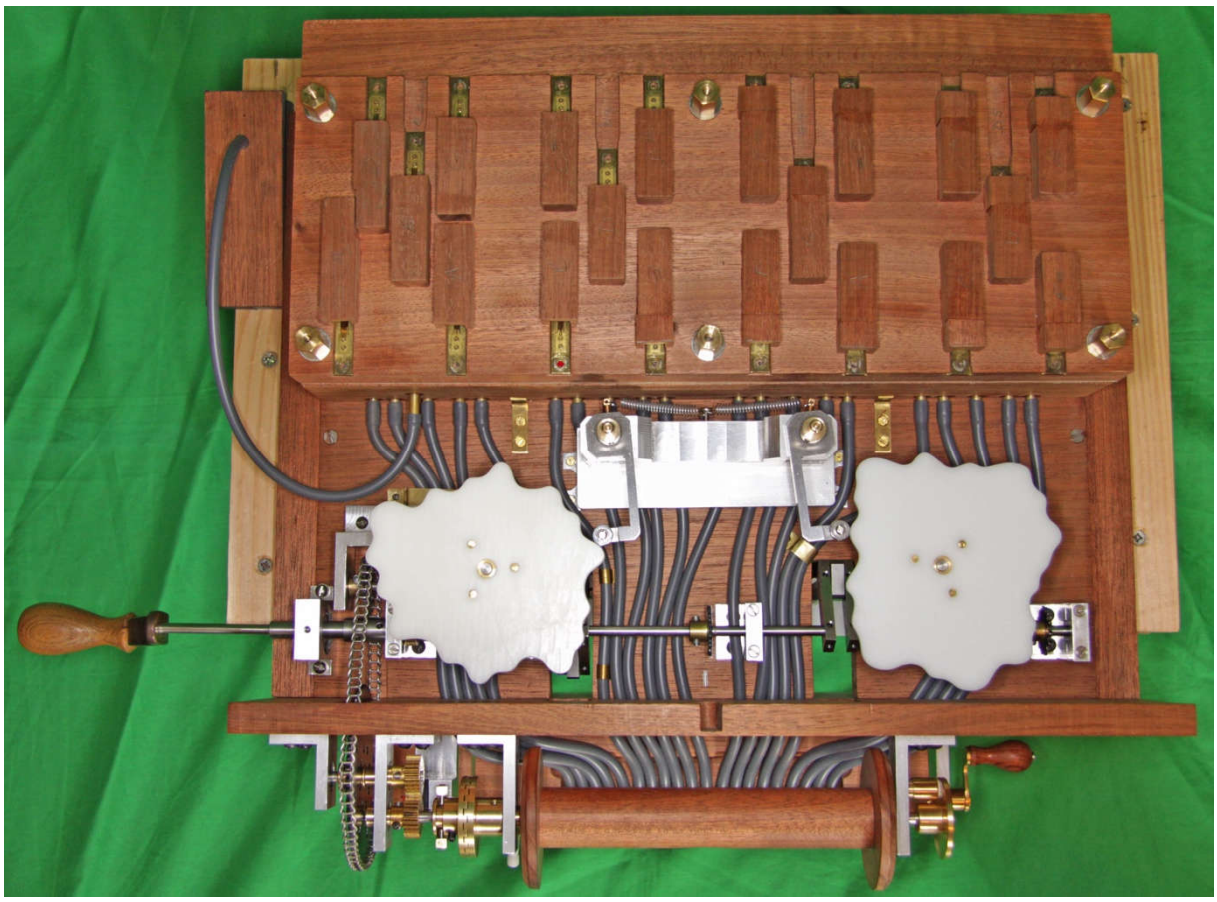

Fig. 6

In Figure 6 you will also notice the wood caps partially covering the reeds. Fully open reeds produce a large number of harmonics and some of the higher order harmonics are not particularly musical. The wood caps are closed at one end, providing a cavity for the sound. As more of the reed is covered the reed produces fewer high order harmonics, so by selectively adjusting the size of the wood cover, each reed can be voiced.

To avoid the dog's tail wag having a 'windscreen wiper' action, a cam with two short lobes provides a pause followed by two swift wags. Again, the cam follower is terminated with a ball race to reduce friction with the cam surface. Connection to the dog is via a follower and push rod, which connects to a paddle extended through the floor from the dog's body.

The tail wag cam assembly can be seen in Figure 7 below;-

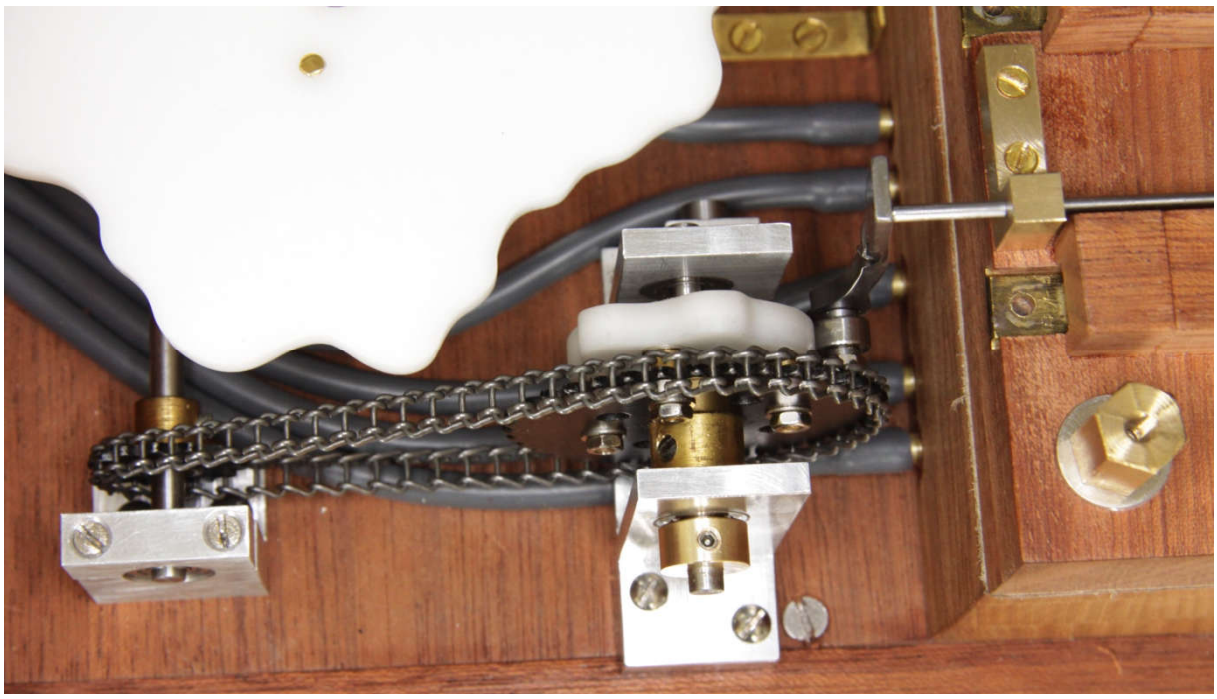

Fig. 7

The dog's eyes were made from a turned sphere of "Delrin" resin with brown glass eyes recessed into the surface. The eyes are mounted on a small shaft with pivots in a ball race bearing. A lever protruding from the left eyeball causes the eyes to normally rotate to the open position under gravity, however a rod connected to the pneumatic in the dog's body holds up the lever effectively closing the dog's eyes. A spring in the pneumatic holds the bellows open. A small copper tube passes through the floor and the dog's body into the pneumatic and this is connected to the vacuum reservoir so that the pneumatic closes as the vacuum is created when playing the instrument, thus opening the dog's eyes. The complete dog chassis assembly can be seen in Figures 8.

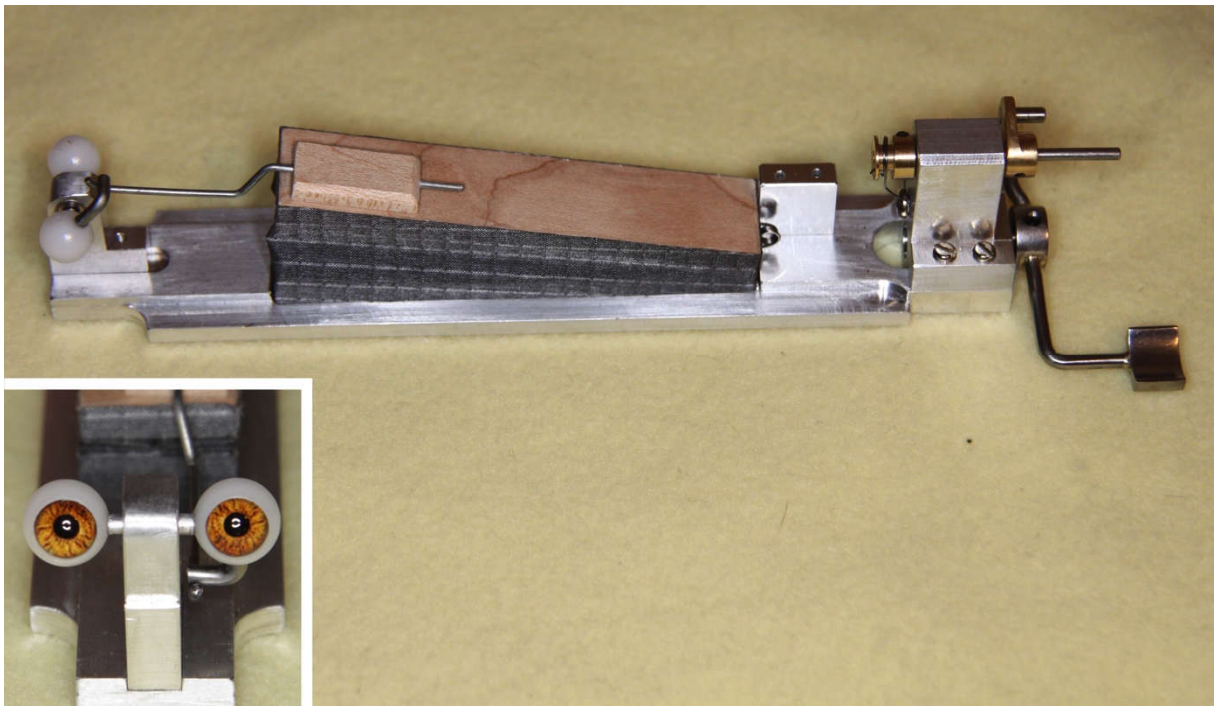

Fig. 8

To complete the dog, the body was carved from Ash and then painted with acrylics.

Fig. 9

The Harmonium was built up as an aluminium chassis with an overlaid walnut case. Figure 10 illustrates the chassis and shows the keyboard assembly. Those keys, which move, have extended tails, which are depressed by the rotating two-lobe cam above. The keys are made from black and white “Delrin”.

Fig. 10

The Harmonium player's torso was also constructed on an aluminium chassis. The upper arms consist of an aluminium bearing block housing two ball races and a shaft which has a cylindrical wood cover. The forearms were carved from Ash and bonded onto an aluminium elbow joint. A single grub screw secures the forearm to the upper arm shaft and also to the control rods, which pass up from the cam followers below the floor. The underside of the hands show the ten Neodymium magnets in each hand, which operate the keys. Ball races are set into the hip joints and there are short removable stub axles, which pass through the bearings and the connecting rods, which were then bonded, into the wood thighs. The neck block is also pivoted on ball races and has a shaft protruding below which connects with a lever at the top of the pneumatic which tilts the head when playing begins. The copper pipe at the base connects via a short rubber tube to a pipe protruding at the base of the player, which fits snugly into a hole in the top of the Harmonium stool.

Figure 11 shows the component parts of the torso:-

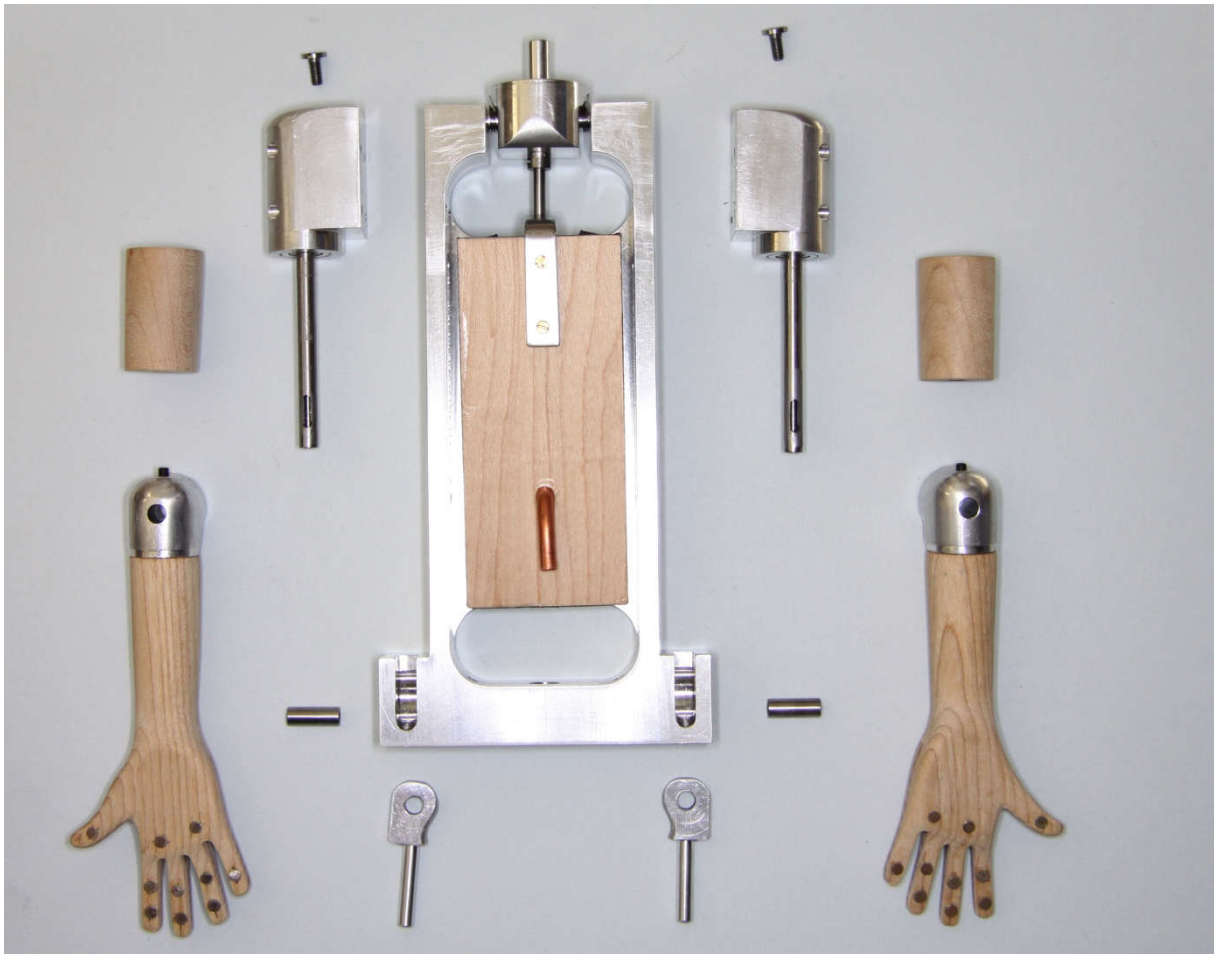

Fig. 11

Front and back body sections were then carved from Beech and attached to cover the torso chassis as in Figure 12.

Fig. 12

The thighs were carved from Beech and have aluminium knee joints which house further ball races to join the lower legs. Removable screw pins allow the legs to be separated at the knee for assembly as the lower leg and shoes are permanently attached to the Harmonium pedals. The shoes/feet are attached to aluminium ankle joints with ball races to make the movable joint to the lower leg. The leg assembly is shown in Figure 13.

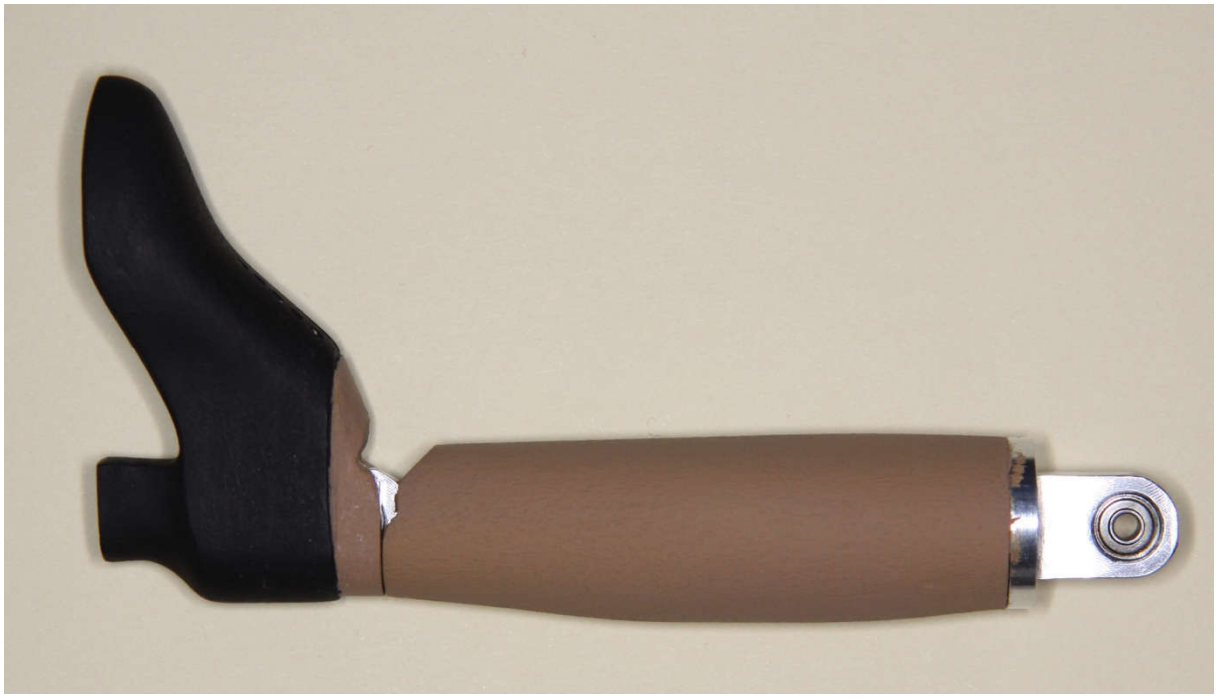

Fig. 13

An open design of stool was chosen copying an Edwardian stool in my possession. A 3mm wide slot was machined into the centre upright of each side to take the 2.5mm diameter control rods. Bonding a veneer strip over the inside face closed the slot leaving a square hole from top to bottom. To operate the head tilt pneumatic a 3mm wide slot was machined on the inside of the right hand front leg following the serpentine curve. At the top, the channel passes across the seat top to the centre hole. The channel was closed to form the airway with a strip of veneer.

Figure 14 shows the player complete (except for her head) assembled on the stool with the completed Harmonium case and dog.

Fig. 14

The Harmonium player's head was carved from Ash. Glass eyes were then inserted from the front and eyelids built up in gesso before painting and attaching a wig. Eyelashes were cut down from material from a doll supplier and attached to complete the head.

A case was then machined from European Oak and to complete the project I enlisted the help of my wife Linda, (who just happens to be a very competent dressmaker), to make her dress.

The finished automaton is shown in the photographs below:-

Fig.15

Fig. 16

Fig. 17

Fig. 18