Edison Digital - The Birth of the Compact Cylinder?

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Phonographs were arguably the first pieces of audio equipment produced for the home market. Phonograph cylinders are readily available from specialist suppliers, antique shops and eBay at prices starting from a few pounds. Over the years, I have built up a small collection of cylinders and had been wondering how good the actual recordings would be if they were converted to an electrical signal and processed using modern computer software.

Figure 1. The Edison Fireside Phonograph

Figure 2. Phonograph Wax Cylinder and Box

Project Aims

Some years ago, I acquired an Edison Fireside phonograph dating from around 1910 which I restored for playing back phonograph cylinders. I considered that this would be the best device to use as a basis for this project, the aims of which were as follows:

- to convert the acoustically recorded ‘hill and dale’ recording to an electrical signal suitable for feeding into a computer’s sound card;
- the process should not risk damaging the original material (i.e. the cylinders);
- there should be no damage to the phonograph or any of its components, such as the reproducer.

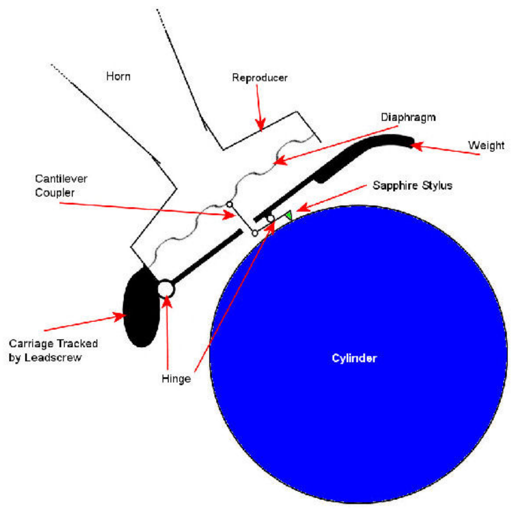

Figure 3. Diagram of a Reproducer

Technical Issues

A phonograph includes a unit called a reproducer that contains a diaphragm. This is linked to a cantilever which holds a sapphire stylus. The stylus follows the modulations in the groove and the diaphragm vibrates accordingly.

A flared horn is attached to the reproducer which acoustically impedance-matches the diaphragm with the room, effectively amplifying the tiny vibrations of the diaphragm.

Like the gramophone record, a phonograph cylinder has a groove cut spirally, but unlike the record, the phonograph employs a lead screw to track the reproducer across the surface of the cylinder. This works as the groove is cut at a constant pitch, which is not the case on a record. As the groove itself does not have to track a stylus across the surface, there are no problems with tracking weight, etc. On a phonograph, the tracking weight is controlled entirely by the reproducer (see diagram).

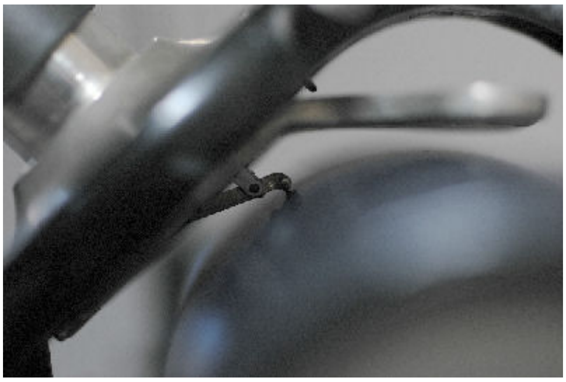

Figure 4. The Stylus Playing a Cylinder

An approach was therefore chosen that utilises a low-cost crystal cartridge mounted on the reproducer, instead of the acoustic horn, and mechanically coupled with the diaphragm.

Construction of the Reproducer Transducer

In view of the above and the fact that crystal cartridges can still be obtained cheaply, I decided on a solution employing a mono crystal cartridge mounted on the phonograph reproducer with a mechanical coupling to the internal diaphragm. The output of such a cartridge would be high enough to drive the input of a computer sound card without any additional amplification. The disadvantage of using a piezo-electric device is that, as previously mentioned, the output is proportional to displacement, not velocity, so there will be a fall-off at high frequencies. This will help with surface noise reduction, and the audio high frequency roll-off can be compensated for by using suitable computer software.

Figure 5. The Reproducer

This solution meant that the existing stylus on the Edison reproducer and playing weight would be exactly the same as if the phonograph were playing the cylinder normally. The cartridge used was a BSR X5H that can be purchased for under £20.

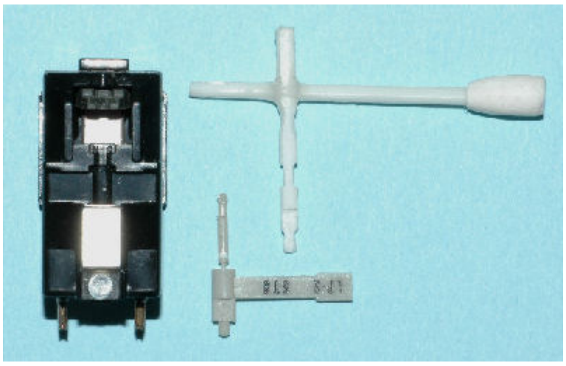

Figure 6. The Cartridge, Original Stylus and New Coupler

Fortunately, I found a standard 15mm pipe clip (obtainable from any plumbing or hardware store) to be a perfect fit to clip onto the reproducer, instead of the horn. I constructed a bracket, using some clear plastic from an old CD case. As the recordings are ‘hill and dale’ and record cartridges are designed for lateral recordings, the cartridge has to be mounted at 90º to the surface of the cylinder. The pipe clip, BSR cartridge and a 3.5mm jack socket were fitted to the plastic to make a neat assembly.

The BSR cartridge incorporates a turnover stylus, which has a tip for playing 78s on one side and LPs on the other. To connect the diaphragm to the cartridge, I fashioned a coupler from two plastic cocktail sticks and fitted it to the cartridge in place of the turnover stylus that is held in place with the metal clip on the cartridge body.

To make the coupler, a cocktail stick was filed to have a profile similar to the stylus so that it fitted the cartridge. The second cocktail stick was glued at 90º to the other stick, making a cross. To make a secure join, some cotton was wrapped around the two sticks at the join and then it was glued using two-part epoxy resin adhesive (see photographs). When the glue was dry, the second cocktail stick was cut to length so that it just touched the centre of the diaphragm when the assembly was fitted to the reproducer.

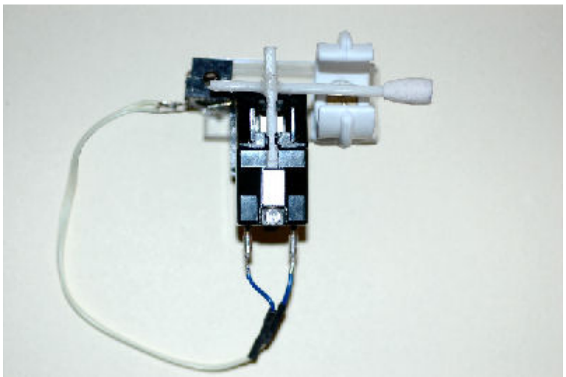

Figure 7. The Transducer Assembly

To prevent possible damage to the diaphragm while making a good physical connection, some white oven-hardening modelling compound was purchased from a hobby shop and this was applied to the tip of the cocktail stick and the assembly was carefully fitted to the reproducer. The modelling compound was gently pressed into the diaphragm so that it took up the shape of the central part of the diaphragm. The assembly was then removed from the reproducer and the compound removed from the cocktail stick and hardened off in the oven. When cool, the now solid compound was glued back onto the tip of the cocktail stick. The whole unit was re-assembled and the cartridge wired up to the jack socket. The unit was then ready for use.

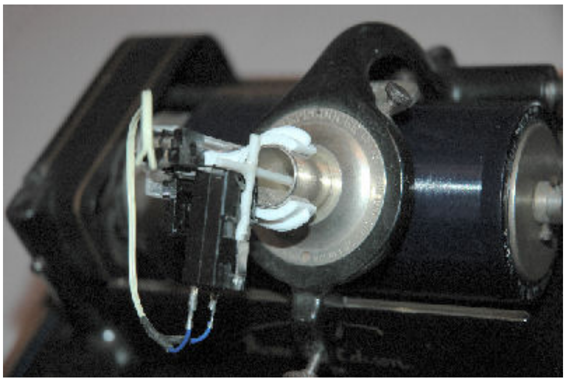

Figure 8. The New Transducer Fitted

Making the Recordings

Connect the cartridge to the signal input of your sound card. It is preferable to use the line input of your sound card, rather than the microphone input, as there should be enough output from the cartridge, but this will depend on the actual sound card you are using.

Before starting the recording, ensure that the main spring is fully wound and the phonograph speed adjusted correctly. Edison was very particular about this. In his instruction book, Edison states that *"All master Records, from which the Edison Records are made, are recorded at a speed of 160 revolutions per minute; and to reproduce these Records perfectly, it is absolutely necessary that the Phonograph should run at the same speed, 160 revolutions* *per minute, no more, no less."* So there - you have been told! Also ensure the cylinder is clean and free from dust. I used a carbon fibre brush made for cleaning records as this was suitable for cleaning both the wax and the Amberol cylinders with no risk of damage.

You are now ready to make your recording. I recommend a two-step process. The first step is to capture the raw signal from the sound card using your audio capture software and save the recording as an uncompressed wave file on your hard disk. These will be about 45Mb in size for a four-minute cylinder.

The second step will be to load the wave file into your sound editor software and make the required adjustments to compensate for the high frequency fall-off of the crystal cartridge and filter out surface noise. The actual process will depend on the software package being used, but the basic requirements will be the same.

It may at first seem to be a conflict of requirements to filter out noise, which is mainly high frequency hiss and clicks, yet boost the upper frequencies. However, the frequency range recorded on a cylinder is somewhat limited and I found that all frequencies above 8 KHz can be safely filtered out. My software package has automatic noise and scratch filters, and these were both activated. I applied some lift at 1, 2 and 4 KHz , neutral at 8 KHz and maximum attenuation above that. I also applied some bass lift at 250 Hz and some attenuation at 125 Hz to reduce rumble from the phonograph mechanism. To determine the best settings, there is really no substitute for listening on good quality headphones connected to the output of your sound card to fine-tune the settings. It is worth spending some time getting it right for each cylinder as there is significant variability between recordings, but you may consider using the above settings as a starting point and experiment from there.

The processed audio was saved as compressed Windows 16 bit mono WMA files with a 22KHz sample rate. The resultant file is about 650Kb in size.

The Final Result

Is all this effort worth it? I have to say that, considering the recordings are nearly 100 years old, I was pleasantly surprised with the results. Not exactly Hi-Fi, but vocals were clear and words could be understood that were rather garbled when played 'normally' on the phonograph with the acoustic horn fitted.

If you want to hear the results for yourself, extracts from several cylinders are available on my web site at http://homepages.tcp.co.uk/~nroberts/phonograph for you to listen to. There is also a recording made using a microphone positioned close to the horn, together with the same piece as a raw recording before processing and a third copy of the final result after processing.

There is a considerable amount of material available on cylinders, including early works of well-known performers such as George Formby and Harry Lauder. Perhaps more importantly, the material captures an impression of the 'pop' music of the time and gives us an insight into the sounds of the music hall era.

If you consider that around 15 cylinders can be saved onto a single CD, it can certainly be said that Edison has now joined the digital revolution!

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