30-Line Television: Baird for All to See!
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There was a book that I had been after for a while having read a fascinating article in the September 2000 issue of The IEE Review[1] on the restoration of early 30-line television pictures that had been recorded on gramophone records. Thanks to my wife, my Christmas stocking last year didn't disappoint me and my spare time has recently been spent reading this excellent book[2] by Don McLean that described the early years of television and the use of computers to unravel the latent images stored on these recordings.

In my record collection I had a BBC LP (see Figure 1) produced in 1976 that was a satirical look-back over 40 years of television by John Bird to celebrate the start of the 405-line television service in 1936.[3] On this LP, there was an 8-second sample of an archive disk that the BBC had found 10 years before in its archives. This archive disk, recorded at 78rpm, contained a test recording comprising a set of still images recorded in the Baird 30-line video format. As it transpired, this test recording was, in fact, a copy of a 78rpm disk sold through Selfridges in 1935 by the Major Radiovision company as an unsuccessful attempt at promoting the concept of television to the general public. I actually had an extract of this on my LP and I wanted to see if I could find a way of revealing the picture that was encapsulated within the 8-second sound-bite!

Figure 1. 40 Years of Television BBC LP

At this point, a word or two about how the Baird 30-line television system worked. It was essentially a mechanical system that scanned the object to be televised using a spinning disc (called a Nipkow disc named after Paul Gottlieb Nipkow who invented the concept in 1883) with a spiral of holes that broke the scene into a number of vertical strips. Referring to Figure 2, it can be seen that there is a photocell that produces an electrical signal depending on the amount of light falling on it. The electrical signal produced by the photocell changes with the varying brightness of each strip as a hole moves from the bottom to the top of the image being scanned. As the holes are in a spiral, the next hole scans another strip slightly to the right of the previous hole. The whole image is scanned once per revolution of the disk and this is called a 'frame'. 30 holes = 30 lines! In the Baird standard, the image is scanned from bottom to top, from left to right and 12½ times per second, or 12½ frames per second.

At the other end, the electrical signal is used to control a light bulb (actually a neon bulb as this can change its brightness quickly in response to the changing electrical signal fed to it) and the viewer looks at the bulb through a similar spinning Nipkow disc. The eye doesn't see the holes of the disc and, due to the persistence of vision, sees the original image as a flickering orange picture. The picture is orange as this is the characteristic colour of the glow of a neon bulb. Of course in the diagram both the scanning and the viewing discs are spinning at exactly the same speed and perfectly aligned with each other. This is essential for

the system to work. However, with real television, the two discs are not linked of course and therefore some method of ensuring that they are aligned and spin at the same speed had to be thought up. This is called 'synchronising' the picture and early television had a very crude method of achieving this, which required the viewer to manually adjust the speed of rotation of his spinning disc to try and match the speed of the transmitted signal!

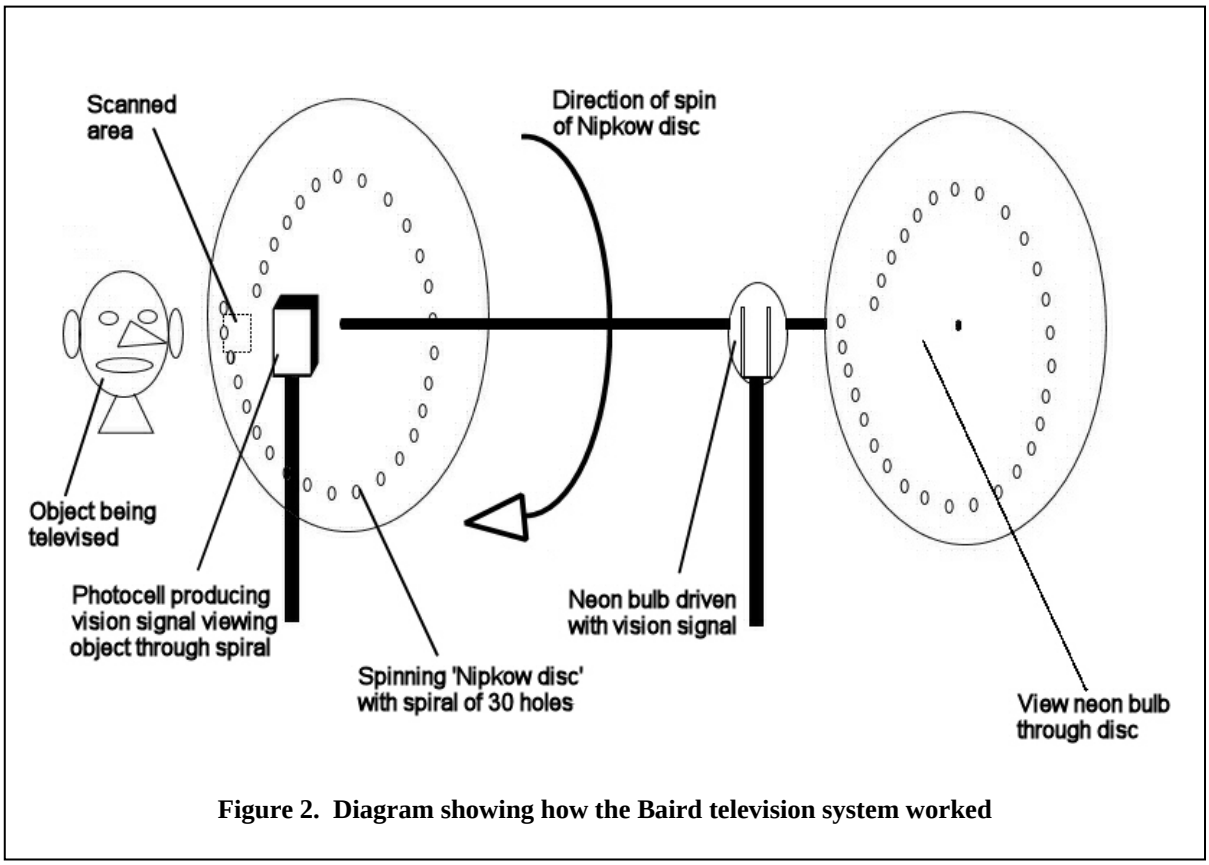

Figure 2. Diagram showing how the Baird television system worked

One advantage of this system is that being a low resolution system, the vision signal doesn't change very rapidly and the frequencies produced by it are within the audio spectrum. This was essential in the very early days of broadcasting as the only transmitter available for testing was the BBC AM radio transmitter in London (2LO). Also, as the transmitter could only transmit at one frequency, either vision or sound could be transmitted, but not both together! So when the BBC started its experimental broadcasts using the Baird 30-line system on 30th September 1929, viewers (or 'lookers-in' as they were known) would listen for the introductions, then they would switch their Televisor to vision to see a picture. Given that the pictures were only transmitted for two minutes at a time and that they had to manually twiddle a knob to synchronise the picture, they didn't have much time to enjoy the programme!

Back to our vision signal, the Baird standard means that the electrical signal is within the audio spectrum, as previously stated. 30 lines and 12½ frames per second means that there are 375 lines per second. Within each line, there will be changes in brightness corresponding to a strip of the image being scanned. If this vision signal is recorded onto a gramophone record and then played back through an audio system, the sound heard will correspond to this vision signal. In practice, it sounds like a harsh, buzzing whine with a distinct pitch. This pitch is, in fact, 375Hz – the line frequency – and is due to the repetitive nature of adjacent lines.

In order to see the picture, I needed to take the signal from my audio system and somehow make it change the intensity of a moving spot on a screen that moved in synchronism with the original spinning disc. A computer would be the ideal device to do this, but achieving this without any synchronising information being recorded along with the vision signal was going to be tricky.

In the late 1970's, I had developed a low-cost system for producing colour television pictures from a black-and-white source by generating a colour television waveform directly, without the use of expensive PAL encoders.[4] The technique was similar to electronically painting a monochrome picture with colour. Key to this approach is a focus on the desired end result. Using a similar approach to my Baird vision recording, I was simply trying to obtain a still picture from the recording at this stage, rather than a moving image, and therefore the fact that there was no picture synchronisation information in the recordings would be less of a problem if I knew the format of the picture information itself.

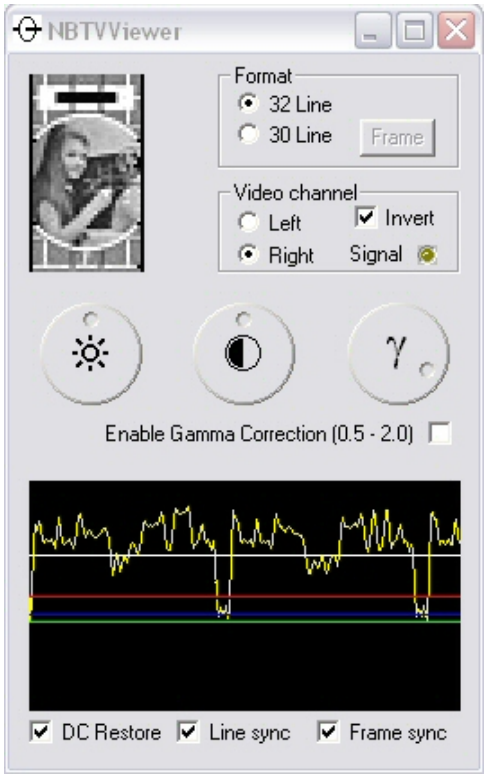

Figure 3. Narrow Band Television Viewer program displaying a modern signal of a familiar subject!

I had two problems to solve: one was to vary the brightness of a spot on the screen of my computer and memorise it over adjacent lines, and the other was to move this in synchronism with the recording. To solve the first problem, I managed to track down an excellent piece of freeware by Gary Millard, a narrow band television enthusiast, and downloaded his NBTV Viewer software.[5] There is a television standard used today by enthusiasts of narrow band television that uses a standard similar to the Baird 30-line format to enable television to be transmitted over short wave radio and other medium. This program takes the audio signal from the computer's sound card and uses it to display an image in the screen corresponding to the audio signal. This, of course, is just what is required to display the picture from my recording.

Figure 4. Faslo program used to adjust the playback speed

I was also able to download a section of Test Card F converted to the narrow band format that I was able to use as a test source. With reference to Figure 3, it can be seen that another useful feature of the program is that is also shows the waveform of the signal fed to it. One of the features of narrow band television is that, in common with a modern television signal, it has synchronisation information embedded within the vision

signal and this can be seen as the negative-going pulses that mark the start of each line. As previously mentioned, my Baird signal has no synchronisation pulses and therefore the program would try and lock onto any negative-going excursions of the video signal, completely messing up the picture. The solution would be to turn off any synchronisation in the program and change the speed of playback to match the 'free-running' frequency of the program. There are a number of programs that can do this and the one I used was called 'Faslo' (Figure 4) which is available for download from most of the on-line shareware software distributors – just type the word 'Faslo' into any search engine, such as 'Yahoo'. This program has a number of features, including changing the tempo without changing the pitch. This feature was disabled as all that is required is to change the playback speed, which is accomplished by changing the number in the 'Set Speed' box that corresponds to the playback speed in percent.

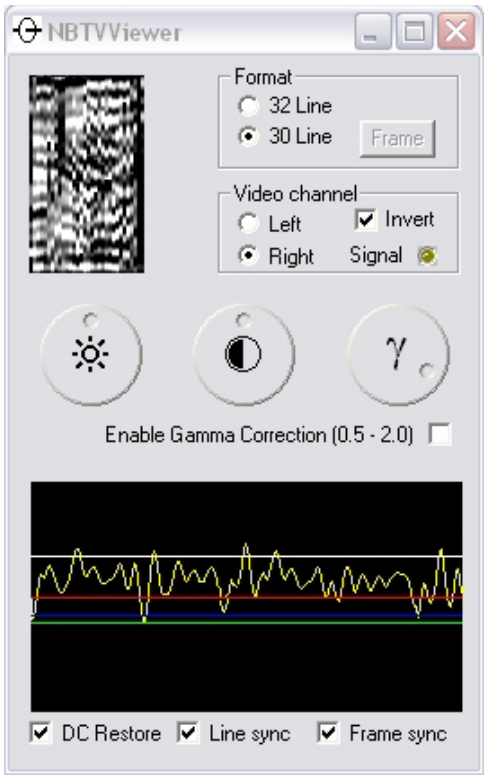

Figure 5. Narrow Band Television Viewer program displaying the BBC signal

Listening to my 'Baird' signal and comparing it to the 'Test Card F' signal, I adjusted the speed of playback using the Faslo program until the pitch was the same. This resulted in a slight increase in speed from the recording to 104%. My adjusted 'Baird' signal was then displayed using the NBTV Viewer (Figure 5) and, as expected, the display was a jumble as the program was trying to lock onto non-existent synchronisation pulses (Figure 6a). However, turning the synchronisation function off resulted in a slowly rolling picture of lines (Figure 6b). Not exactly recognisable, but I was encouraged to see something at all!

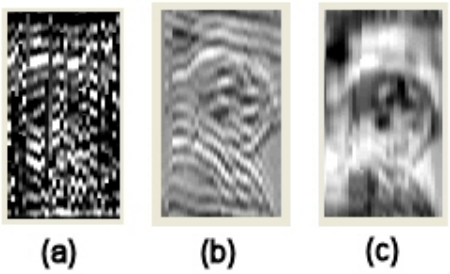

Figure 6. The Baird-format image finally revealed

At this point, I remembered reading in Don McLean's book that the original Major Radiovision disc suffers from a 5KHz ringing, which was probably caused by resonance in the cutter used to make the record. Armed with this knowledge, I used the graphic equaliser facility in Windows Media Player to notch out frequencies around 5KHz and tried again. This time, I obtained the image shown in Figure 6c that clearly shows a picture of a young girl. So this was the latent image locked away on my LP all these years!

Figure 7. The Baird-format image finally revealed

To find out what the picture should look like, I referred to Don McLean's web site[6], which contains details of all his work over the past 20 years to decode the images on 30-line television recordings, including the Major Radiovision disc and the 5 known unique copies of Baird's Phonovision, which contain the world's first recordings of television. Don McLean's site includes the still images that he has decoded from the Major Radiovision disc. With reference to Figure 7, it would appear that the fourth image along on the top row is the image recoded on my LP. My image is slightly distorted due to what is called 'arc-scanning'. This is caused by holes the Nipkow disc moving in an arc, rather than vertically. Don McLean has corrected for this with his software.

Spurred on by success with my LP, I noted that Don McLean has provided sound clips of each of the 5 unique Phonovision discs produced by Baird (see Table 1).

Catalogue Number	Date	Comment
SWT515-4	20 September 1927	Dummy Head with large speed fluctuations
RWT620-4	10 January 1928	Man's Head in Motion marred by over-modulation
RWT620-6	<No Date>	Man's Head in Motion marred by amplifier resonance
RWT620-11	10 January 1928	Man's Head in Motion
RWT115-3	28 March 1928	'Miss Pounsford' with fast timebase resonance

Table 1. The five unique Phonovision discs

I should mention at this point that Phonovision was invented by Baird as a means of recording television images on a record that was mechanically linked to a replay mechanism involving a Nipkow disc. Phonovision discs are therefore not necessarily recorded at 78rpm. The sound clips do not sound much like the BBC test disc or Major Radiovision disc. The pitch sounded much lower and so I used the Faslo program to increase the pitch (this time by over 400%) to enable me to create a sound clip that would have video at the correct speed for the NBTV program, i.e. at 375 lines per second. Although this would mean that any movement in the video would be too fast, it did enable me to capture some still images from the Phonovision discs and my results are shown in Figure 8.

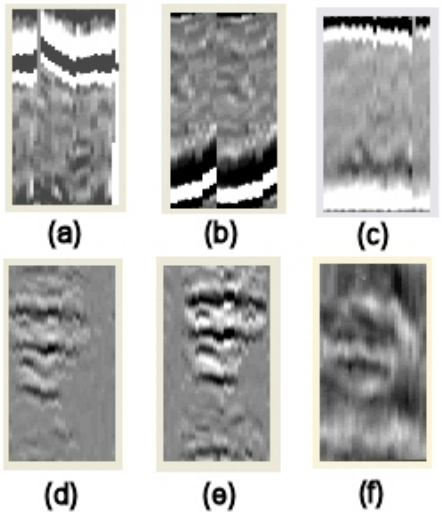

Figure 8. Images from the Phonovision discs:
(a) SWT515-4 – Dummy Head
(b) SWT515-4 – Dummy Head
(c) SWT515-4 – Dummy Head
(d) RWT620-11 – Man's Head
(e) RWT620-11 – Man's Head
(f) RWT115-3 – Miss Poundsford

Most of the images needed editing in my graphics package to compensate for alignment errors. Most likely these were caused by misaligned lenses on the Nipkow disc (lenses were used instead of holes in Baird's later work) or, as in the case of the 'Miss Poundsford disc, speed variations during the recording caused by mechanical resonances on the linkage mechanisms. Although Figures 8(a)-(c) are very poor, I felt it was worth including them as they are images of one of the original Baird dummy heads ('Stookie Bill') that he used in his early experiments.

To see what can actually be revealed from the discs, see Don McLean's web site. Some of his images are reproduced here in Figure 9. This site contains movie clips and animations of the actual video playing at the proper speed! It is worth noting at this point that the quality of the pictures actually seen by 'lookers-in' at 30-line television in the 1930s would have been considerably higher. These images have suffered from the recording processes used at the time.

Figure 9. Don McLean's Images from the Phonovision discs:
(Top) SWT515-4 – Dummy Head with hand moving in front
(Bottom) RWT115-3 – Miss Poundsford. The last image is a photograph of the lady herself!

I have to say that I found the exercise to be a fascinating insight into the work of one of the early television pioneers. If any members have some old 30-line recording lurking in their loft, I would love to hear from them!

And where did all this take us? On Monday, 2nd November 1936, the BBC launched the very first television service at 3:00pm using Baird's 240-line system. Then at 4:00pm, the same programme was transmitted using the Marconi-EMI 405-line system. Thus was the start of the world's first high definition television programme transmission – and it was a repeat!

ACKNOWLEDGEMENT

I am indebted to Don McLean for his kind permission to reproduce his work in Table 1, Figure 7 and Figure 9 above.

REFERENCES

[1] D F McLean, 'Restoring Baird's Image', *IEE Review*, September 2000 (©IEE 2000)
[2] D F McLean, 'Restoring Baird's Image', IEE, ISBN 0 85296 795 0, September 2000
[3] 'We seem to have lost the Picture', *BBC LP from the series '40 Years of Television'*, 1976, REB239
[4] N C Roberts, Colour synthesizer design for the PAL system, *Wireless World*, August 1979, pp69-73
[5] Web site: http://www4.tpgi.com.au/users/gmillard/nbtv.htm
[6] Web site: http://www.tvdawn.com/index.htm

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