Photoliptophone: A virtually unknown ancestor of optical audio systems to reproduce printed sound on plain paper

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Abstract

The Photoliptophone was a system developed by Argentinean inventor Fernando Crudo in the 1930s. The system allowed recording audio waveforms on radiographic plates, so that they could be printed on paper. The aim of the system was reducing the distribution cost of audio copies by including the printed waveforms in magazines and newspapers. The Photoliptophone obtained patents in thirty countries. National and international reports evaluating the operation of the prototype describe the Photoliptophone as a system with good audio quality. The system remained in operation for two decades, although it never managed to successfully enter the market as an alternative to mechanical recording systems.

In the same period of time, a recording system known as Selenophone was developed in Austria. It used 7mm film to record audio and which could be printed on reels of paper to be later reproduced as sound. The aim of the system was to record over longer time periods than mechanical systems allowed for, as well as printing copies on paper to reduce the cost of film as physical support.

This paper describes the operational principles of the Photoliptophone and compares it to the Selenophone. Original documents related to the Photoliptophone have been analyzed for this study. Such documents include patents, inventor’s personal letters, official use permits, business plans and audio waveforms printed on either paper or radiographic film.

An evaluation of the audio quality of the Photoliptophone is also reported in this paper. Original printed audio waveforms that remained untouched for the last eighty years have been scanned. The associated audio was retrieved by means of numerical processing of the scanned images.

Keywords: Sound recording, ancient recording systems, oscillogram, phonogram.
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1 Introduction

In the first decades of the XX century, the sound recording and reproduction were dominated by mechanical methods. The prototypes based on magnet means had not been much development. There were important improvements triggered by the movie industry in the optical methods of sound register.

The mechanical methods recorded the audio signal as grooves in a physical support. The reproduction itself deteriorated the copy’s quality. The technology available allowed reproductions of about five minutes long depending on the chosen frequency response and the dynamic range [1].

The optical methods of the sound cinema consisted of printing oscillogram on celluloid, which allowed better levels of dynamic range and frequency response than the mechanical ones, due to the high resolution available on the celluloid prints. The recording’s length could be substantially longer. Based on these principles, it could be expected the development of more systems dedicated to high quality audio with this technical advantages available. However, the optical audio recording was associated with the sound cinema, probably due to the high cost of the nitrated-based film.

At the end of the 1920’s and beginning of the 1930’s a few systems, which tried to obtain oscillogram’s copies on paper, appeared. We had closer access to two of those few systems. The first one called Photoliptophone was developed in Argentina, of which our team made the research of the primary documents available. The second one was the Selenophone, developed in Austria, of which there is documented information [2].

2 A brief history about Photoliptophone

In 1930 Fernando Crudo (1906 – 1974) submitted the patent application in Buenos Aires, Argentina of an optical device to record and reproduce audio on paper, called Photoliptophone [3]. The name emerges from the combination of Photography, Litography and Phonography.

The system used an optical process for the recording and reproduction, to obtain a plain rectangular paper sheet of 50 cm x 40 cm, containing an oscillograms series in parallel tracks of 1.5 mm each (figure 1).
The inventor's aim was to achieve an economic way to mass distribution of music and sounds using paper as storage [4].

The recording was made wrapping a X ray film in a cylinder of 16 cm diameter, which spin at 85 r.p.m. in a dark room. The voltage fluctuations delivered by a microphone were amplified and they supplied an oscillograph, which exposed a light sensitive film leaving a waveform register. Such oscillograph progressed in a parallel way to the axis, leaving an helical trace on it. The x ray was developed and then with ordinary printing methods, the paper was printed.

The player consisted of a cylinder of equal measurements and rotation speed, where the sound sheet was placed. (figure 2). The oscillogram was illuminated by a beam of light causing a reflection captured by a photoelectric cell, which converted the light fluctuation into voltage. The size of the illuminated area should capture all the track width, but it should be narrow enough not to lose the high frequency. The sound sheet could have as many as 330 tracks, obtaining a duration of about 4 minutes.

With warm approval, hundreds of Argentinean specialized newspapers and magazines of the time described the features and advantages of the invention. The device was also successful in some Spanish, American and Australian newspaper and magazines [5 6 7].

During the 1930’s several investments were made to patent, industrialize and to spread the invention in 31 countries with no commercial success. In the forties the National Archives acquired a Photoliptophone recorder in order to preserve speeches and sounds native of the
country, creating the Word Archive (Archivo de la Palabra) [8]. Also an experimental phonetic laboratory got an equipment to carry out researches analyzing visually the recorded phonemes, fitting attaching an enlargement system of the oscillograms [9]. This work’s results were published in the book “Problemas de fonética experimental [10]”.

3 A brief history about Selenophone

From early to mid 1930’s, Oskar Czeija (1887-1958) developed the Selenophone (figure 3) in Austria, the invention used optical principles to record and reproduce sounds printed on paper. The name comes from the combination of “selenium cell” and “phonography”. The inventor’s aim was to achieve long duration records of music and sounds using paper as storage.

For the recording process, the Selenophone used the optical soundtrack portion of the recently developed sound-on-film process being used on 35 millimeter talking motion pictures. Using a special cutter they removed the image and the perforated sides leaving the remaining 7 mm for sound recording. A light beam coming from the oscillograph reaches the passing film creating vertical images corresponding to the incoming audio signal. The film tape velocity was about 50 cm/second approximately. The invention patent describes a velocity of 45.6 cm/s [11], while posterior references indicate a velocity from 50 to 60 cm/s [2]. Once the audio was recorded the film tape required a developing process identical to the one used in movies. The result was an oscillogram printed on paper tape.

For reproduction the oscillogram was illuminated by a beam of light causing a reflection captured by a selenium cell, which converted the light fluctuation into voltage. The paper tapes were 305 meters long (1000 feet) which allowed 35 minutes audio recordings without interruptions. An advantage of the process made it possible to have multiple positive prints from an original negative without any loss in sound quality from one copy to the next.

![Figura 3: Selenophone: photo and diagram](image)

Figura 3: Selenophone: photo and diagram
4 Audio recovery

Five operas have been preserved from the Selenophone register in 1937 in the Salzburg Festival in Austria. The operas are Die Meistersinger, Falstaff, and Die Zauberflöte directed by Arturo Toscanini and Le nozze di Figaro and Don Giovanni with Bruno Walter.

Some correspondence from Karl Czeija (Oscar’s son) to Walter Toscanini (Arturo’s son) in 1964, indicates that Czeija was having no luck unearthing any other performances of the Selenophone anywhere in Europe [2].

During the late 80’s Rodgers and Hammerstein Archives began to work on the Toscanini legacy. Since there were different copies previously made in different formats that were considered inaccurate, they decided to rebuild the device with some adaptations to recover the original audio from the film tape. The recovered music plays were commercialized in CD and LP formats [12].

From the Photoliptophone, there are still some sound sheets preserved on paper and x-ray photograph. Our team had access to the only one Photoliptophone player left, owned by Fernando Crudo’s son, but the device malfunction didn’t allow the sound sheet reproduction. Then sound sheets were digitalized in order to obtain the sound recorded properly through MATLAB to convert the oscillograms into audio [13]. The deep studies of the documentary archives tell us that hundreds of sound sheets were made with the Photoliptophone. Twenty-two sound sheets have been recently found and are in the recovery process. Any attempt to compare the original systems audio quality from the recovered sounds will be inaccurate since there are multiple factors that modify the recovered audio characteristics. For example, the Salzburg festival was transmitted by phone to Vienna where the Selenophone registered it [2]. Any possible quality loss in the phone transmission was registered among the music.

There are limitations in photographic audio recording methods due to the oscillograph characteristic. The Photoliptophone used an oscillograph’s frequency of 20 kHz, allowing a 10 kHz limit in frequency response. There are also some limitations in sound sheets reproduction process due to the width of the cell’s sensed zone related to the tangential speed which determine the maximum frequency. This resembles the magnetic recording by linking the air gap and tape velocity.

Based on Crudo’s documents the inventor settles an 8 kHz frequency response for the Photoliptophone consistent with the use of recording optical systems of the time. Some reports on the Selenophone describe an 8 kHz frequency response by the use of an adaptation of cinematographic audio pick up equal to the recording and reproducing optical systems used on sound film on that decade.
5 Conclusions

Crudo and Czeja designed new recording and audio reproduction systems combining different elements that were already developed in industry. Both inventions had similarities as well as goals that distinguish one from the other.

The Selenophone stood out by solving one of the sound recording problems of that time: regular recordings did not last more than 4 or 5 minutes. By using 35 mm film created for cinema productions, it could carry out operas, arias and concerts recordings up to 35 minutes without interruptions. On the other hand, Crudo used the 40 cm x 50 cm x-rays negatives to develop the Photoliptophone sound sheet. The sound recorded in it did not last much longer than the gramophones of that time but by having a size similar to an usual newspaper page, sound sheets were allowed to be included on newspaper. Crudo’s goal was to facilitate an economic and agile way for music distribution.

Both inventions allowed very low cost copies and stopped their development by the time World War II started. Neither of them reached the market either as a popular or as a massive consumer device. Apart from the relevance obtained by the Photoliptophone and the Selenophone during those years, both devices remained unknown to the public.

Acknowledgments

Fernando Crudo hijo, Claudia Bertolo, Daniela Toledo, Marina Bello, Guadalupe Perez Spada,

References


