

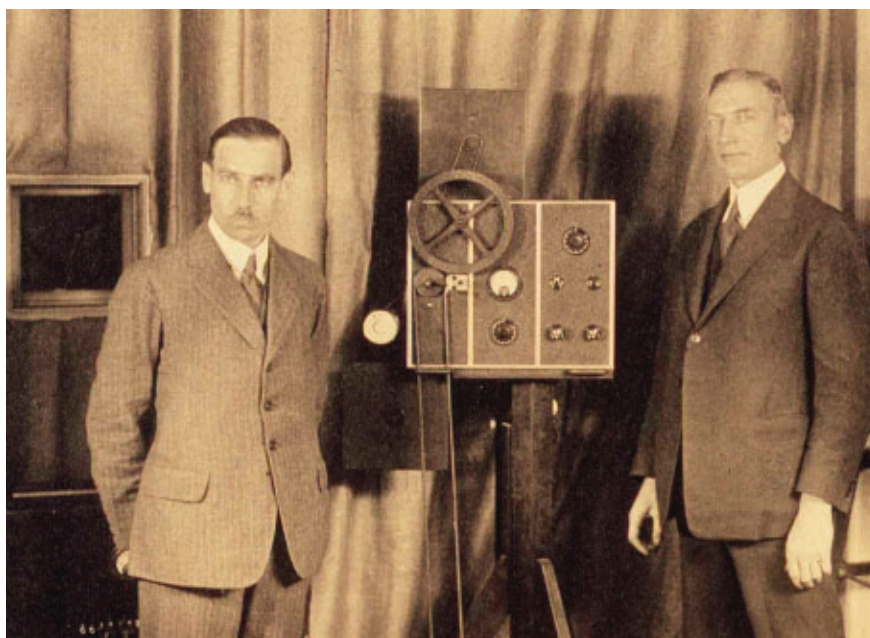


Preservation of early sound films

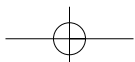
UFFE LOMHOLT MADSEN

For many years some short films have been stored in the nitrate vaults of the former Danish Film Museum, which is now a part of the Danish Film Institute. Files on these shorts reveal a dismal remark: "Old sound track, cannot be replayed", referring to the wide sound tracks on separate 35mm films. In other words: the experimental photographic sound films of Petersen and Poulsen.

In 1918 the two Danish engineers, Axel Petersen (1887-1971) and Arnold Poulsen (1889-1952), joined The Electrical Phono Films Company, founded in 1917 by a group of financiers. Petersen and Poulsen had known each other since university. They were classmates and both graduated in 1912 in the first class of electrical engineers from the Technical University of Denmark. The company's only goal (apart from making money) was to develop a sound system with an acceptable fidelity, in synchronization with motion pictures. The electrical technician who had initially requested the financiers for help to found the company, working with an electrical engineer, had not been able to solve the problem. So in 1918 Axel Petersen was asked to have a go. He agreed on condition that he could do so with his old classmate Arnold Poulsen.



Arnold Poulsen and Axel Petersen with their first sound camera.

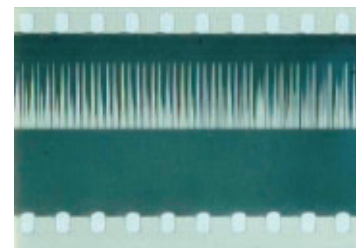




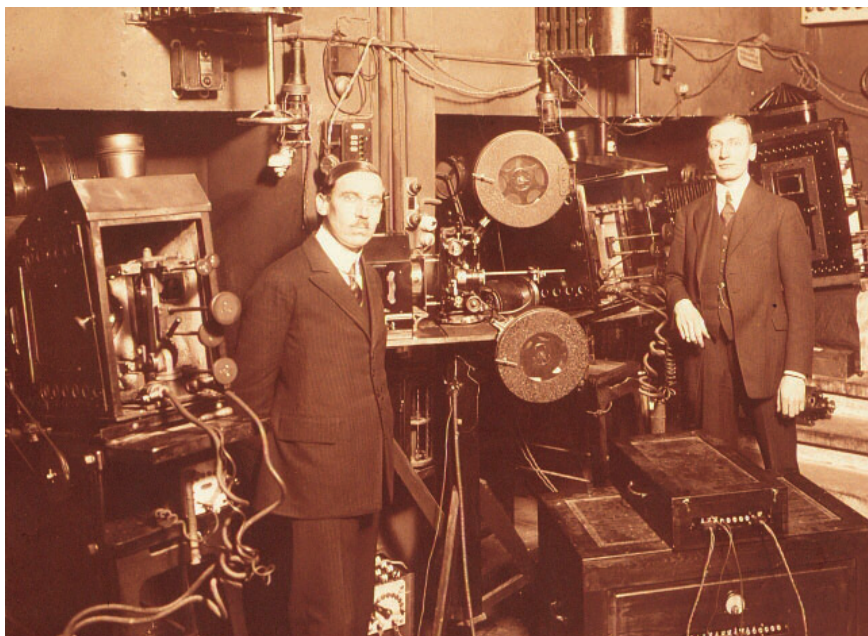
Five years later, on 12th October 1923, Petersen and Poulsen were ready to demonstrate the result of their combined efforts before an audience at the Palads Theatre in Copenhagen. Petersen and Poulsen had chosen a variable area sound, a system already used with very little success by the French Eugene A. Lauste since 1910. Lauste abandoned his attempts at around the start of the First World War. However, Petersen and Poulsen used a separate film for the sound track. The 1923 demonstration programme consisted of two parts with an intermission. The film started with an address by a well known journalist followed by seven well known Danish actors and singers performing one by one (one of the features did include two actors, however) on the screen with picture and sound fully synchronized.

The film ran for 20 minutes. The picture film was a 35mm full-frame 1.33:1 shot at 16 frames per second (fps). The photographic soundtrack on a separate film, a unilateral variable area about 9mm wide, was also on a 35mm film running at 32 fps. Parts of the film were shown as a short before a silent film later in 1923. But since 1932 the film has never been shown.

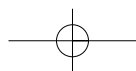
The original picture and sound negatives were lost long ago. However, by a miracle the print used on 12th October 1925 has survived and was acquired by the Danish Film Museum in shreds and patches together with some other films in 1988. The reels had previously been stored in airtight cans. We soon realized that some of the pieces of film originated from the demonstration film of 1923. But in the spring of 1991 we realized that we in fact possessed the complete film.

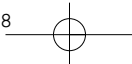


The 9 mm unilateral variable area sound track.



Arnold Poulsen and Axel Petersen at the Palads Theatre in October 1923.





Since 1988 we have been concentrating on restoration of soundtracks made by Petersen and Poulsen from 1929. These tracks are also on separate 35mm film but 24mm wide with both picture and sound running at 24 fps.

A playback machine for 24mm tracks was made. This unit also has a noise reduction shutter with adjustable sensitivity and bias. The machine is able to play back all optical soundtracks on 35mm film. The slit can be masked according to the width of the soundtrack concerned. The frequency response is flat from 40 to 8,000 Hz.



The 24 mm variable area sound track.



A replay machine was constructed in 1988 by Magnus Christensen.

Very few modifications of the playback machine were necessary to have it fitted for 9mm tracks. Some gear wheels were changed in order to obtain the necessary 32 fps, a new shutter blade for the noise reduction was made and the slit was masked. The soundtracks were re-dimensioned for reduction of wow, and then transferred to full track 1/2 inch audio tape at the speed of 15 inches per second (ips). As the playback machine is driven by a synchronous motor the mains frequency (50 Hz) is recorded as the pilot signal on the tape.

One of the features included a singing actor playing the lute. A lute expert was called in. He first watched the film on video to identify the chords played, and then simply tuned the tape speed by means of a 440 Hz concert pitch reference and a vari-speed connected to the tape recorder.

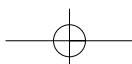
It was now possible to determine the speed of the demonstration film more precisely: 15.2 fps for the picture film and 30.4 fps for the soundtrack film. We know that the sound camera (which also drove the camera) was manually adjusted with reference to a tachometer.

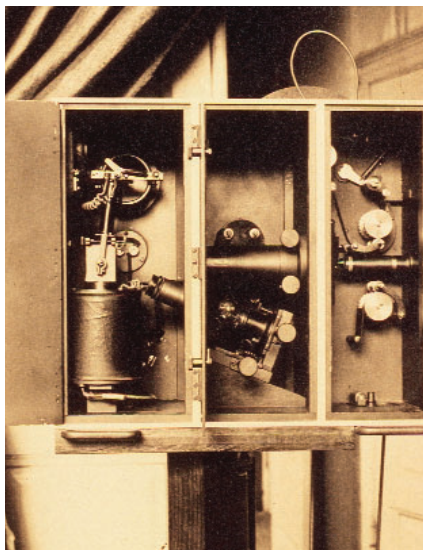
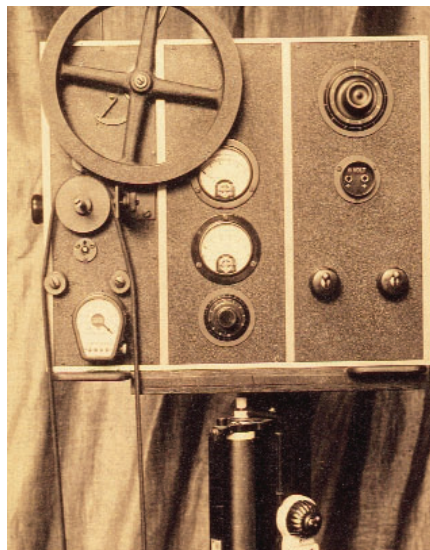
The presumption is that Petersen and Poulsen had chosen 16 and 32 fps respectively, but owing to a typical error in the tachometer, the film was recorded at a speed 5% lower. Having every second frame printed twice meant that the final print with combined picture and sound had to be shown at 22.8 fps.

We did not make any further improvements to the soundtrack. But this almost raw version boasts a signal-to-noise ratio of 35 dB with impressive speech intelligibility.



A lute expert tunes the tape speed.





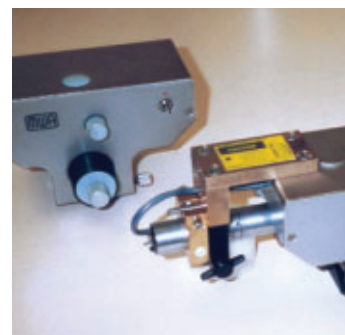
The first Petersen & Poulsen sound camera.

In the early 90's we purchased a MWA MB51 magnetic film recorder made by the Berlin company W. Albrecht. It came with interchangeable head blocks for different perforated tape widths: 16, 17.5 and 35mm along with replay head blocks for conventional photographic sound tracks on 16 and 35mm films. In 2000 we commissioned W. Albrecht to make a special head block for replaying any analogue optical sound tracks in mono ranging from a width of 24mm to any narrower size positioned anywhere between the two perforation rows.

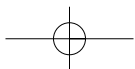
The slit width can be adjusted by means of two knobs which drive two diaphragms or masks. It uses laser light with a wavelength of between 600 and 710 nm. By moving the focus of the laser light it is possible to adjust the slit length, which is normally specified to 25 microns; this is also the fixed slit length for our mono head for conventional sound tracks on 35mm film.

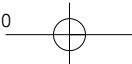
The demonstration film from 1923 was restored from the original prints. So the sound was replayed from a positive sound track, but most of the existing material of the Petersen and Poulsen films from the 20s in our collection consists of the original negatives. We have therefore made a number of test prints of the sound tracks in order to ascertain the density with the best sound. These Petersen and Poulsen sound tracks have a low density compared to modern analogue sound negatives.

The highest density we measured was 1.62 and the lowest was 0.96. On the same sound negative it was possible to measure 5 different densities ranging from 1.09 to 1.62. The so-called clear base (which is the part to become black on the positive of course) varied from 0.13 to no less than 0.34. The varying densities even as late as 1929 seem to indicate that Petersen and Poulsen were still not aware that although



Conventional head block (left) vs. laser head block for the Petersen and Poulsen wide-track system.





Film	Density of BSN	Density of BSN base	Density of new BSP
1	0.96	0.34	1.10
2	1.56	0.14	1.07
3	1.43 + 1.57	0.14 + 0.16	1.24
4	1.47	0.18	1.16
5	1.94 + 1.63	0.16	1.16
6	1.64	0.29	1.12

Tabel 1. Petersen & Poulsen's 24mm sound tracks. Examples of different densities

the quality of sound reproduced by the variable-width type of record does not depend much upon the conditions of exposure or development of either the negative or positive at lower frequencies, it certainly does when higher frequencies are recorded, calling for correct exposure and development. It was indeed long before cross-modulation tests and special sound negatives were introduced. At that time anything higher than 6,000 Hz was uninteresting, and the real distortion problems occur at higher frequencies, as stated. It is nevertheless important to match the sound positive as well as possible to the negative. In one case we made 16 exposure steps on the same sound positive ranging from 0.48 to 2.08. In all cases a Bell & Howell panel printer was used, simply by inserting the soundtrack into the picture gate for Super 35mm.

The Petersen and Poulsen sound films from the 20s can be divided into three groups. They all have the pictures on a separate film in a 1.33:1 aspect ratio

Year	Picture film		Sound track film	
	Aspect ratio	Speed	Track width	Speed
1923	1.33:1	16 fps	9mm	32 fps
1925	1.33:1	20 fps	24mm	20fps
1928-29	1.33:1	20 fps	24mm	20 fps

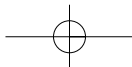
Tabel 2. Petersen & Poulsen's 35mm double-band system of the 20's. Technical survey.



Photo from 1928 left to right: Axel Petersen, Carl Bauder, Arnold Poulsen and Selmer Trane.

In the mid 1920s a number of companies were formed in England, France and Germany to exploit the Petersen and Poulsen-system. Axel Petersen even toured the United States to promote the system, but the tour was too late and proved a failure since several companies were already using single-film systems. In 1929 Petersen and Poulsen themselves changed to a single film system very similar to RCA's Photophone system, and they soon developed a noise-less system. In the beginning it was too noiseless! It choked the signal if it was too weak, but within a few years the system was very close to today's bilateral system, where an unmodulated part of the soundtrack consists of two narrow transparent lines.

The once internationally successful *Nordisk Films Kompagni*, a Danish film company founded in 1906 by Ole Olsen, had declined since World War I. A stockbroker and member of the board of directors at Nordisk, Carl Bauder (1882-1944), took over Nordisk in 1926, but initially lost a lot of money. The company failed in 1928. Bauder



knew Selmer Trane, the owner of an electro-technical factory and had the utilization rights for Denmark, Finland, Norway and Sweden of Petersen and Poulsen's patents. Bauder and Trane reshuffled Nordisk in 1928 and it continued trading as *Nordisk Tone-Film*. Selmer Trane manufactured the necessary replay equipment for the system. The Petersen and Poulsen double band system was used till 1929. Only short films were produced. They were not a popular success. The technology was dubious, not at least due to the amplifiers and loudspeakers. Today the films are historical treats showing artists from the past, some of whom only appeared in front of a motion picture camera on these occasions. With today's improved equipment it is possible to do the old sound tracks far more justice. At that time it was obviously an advantage to use a separate film for the sound track, allowing the photographic processes to be adjusted independently of the sound. In a way Petersen and Poulsen followed the line of least resistance, but it was actually a wise strategy which permitted them to refine the technique at a given developmental stage so they could concentrate their efforts solely on the sound. Apparently the quality of the sound camera galvanometers and the condenser microphones also seem to contribute to sound quality that is now and then surprisingly good.

In 1930 Nordisk produced its first feature film with sound, *Eskimo* (Schnéevoigt, DK/NO, 1930). The partnership between Carl Bauder and Selmer Trane ended in 1936. The company returned to its former name, *Nordisk Films Kompagni*. Trane withdrew from Nordisk, but the company continued using the Petersen and Poulsen single-film system, and had to pay Petersen and Poulsen's Electrical Phono Films Company for using its sound system.

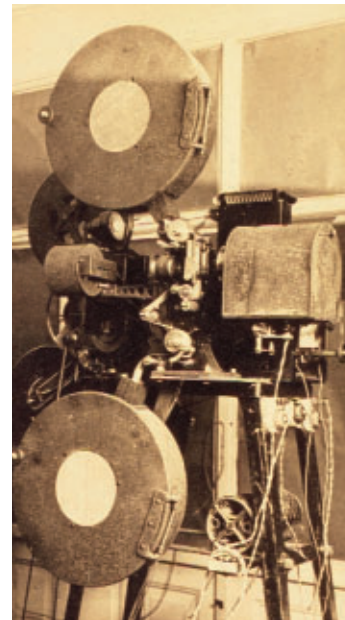
Year	Production numbers	surviving numbers
1923	8	8
1924-28	8	8

Tabel 3. Electrical Fono Film Company A/S.

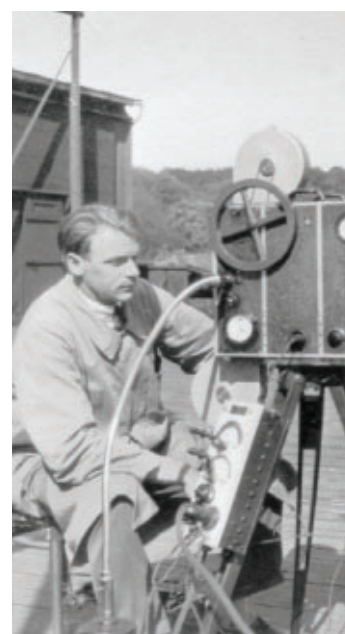
Year	Production numbers	surviving numbers
1928-29	74	29

Tabel 4. A/S Nordisk Tone-Film.

The Electrical Phono Films Company continued developing sound equipment. In the late 1930s a compact 16mm camera was launched, initially a modified Ciné-Kodak Special holding 400 feet film and capable of recording picture and photographic sound onto the same piece of reversal film with amazingly good sound quality. Several patents made a profit for the two engineers. At the end of World War II the company developed a cutterhead and amplifier for the disc recording industry of such high quality that there was soon a need for a correspondingly good pickup to do justice to the new cuttings. In 1948 the famous moving coil pickup was launched – a pure mono pickup constructed to read only horizontal tracking. The old name Electrical Phono Films Company was changed to *Fonofilm Industri* in 1946 and in 1951 *Ortofon* was founded as an associated trading company. Ortofon pickups are manufactured to this day and are the most renowned in the world.



Double-band replay equipment.



Sound engineer Henning O. Petersen with the Petersen and Poulsen sound camera at Nordisk Films Kompagni's studios.