DIGITAL AUDIO AND COMPACT DISC TECHNOLOGY

Second edition

Digital Audio and Compact Disc Technology

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Preface

The past century has witnessed a number of inventions and developments which have made music regularly accessible to more people than ever before. Not the least of these were the inventions of the conventional analog phonograph and the development of broadcast radio. Both have undergone successive changes or improvements, from the 78 rpm disc to the 33⅓ rpm disc, and from the AM system to the FM stereo system. These improvements resulted from demands for better and better quality.

Now, another change has taken place which will enable us to achieve the highest possible audio fidelity yet – the introduction of digital technology, specifically pulse code modulation (PCM). Research and development efforts, concentrated on consumer products, have begun to make the extraordinary advantages of digital audio systems easily accessible at home. Sony is proud to have been one of the forerunners in this field, and co-inventor of the compact disc digital audio system, which will lead to an entirely new level of quality music.

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A Short History of Audio Technology

Early Years: From Phonograph to Stereo Recording

The evolution of recording and reproduction of audio signals started in 1877, with the invention of the phonograph by T. A. Edison. Since then, research and efforts to improve techniques have been determined by the ultimate aim of recording and reproducing an audio signal faithfully, i.e., without introducing distortion or noise of any form.

With the introduction of the gramophone, a disc phonograph, in 1893 by P. Berliner, the original form of our present record was born. This model could produce a much better sound and could also be reproduced easily.

Around 1925 electric recording was started, but an acoustic method was still mainly used in the sound reproduction system: where the sound was generated by a membrane and a horn, mechanically coupled to the needle in the groove in playback. When recording, the sound picked up was transformed through a horn and membrane into a vibration and coupled directly to a needle which cut the groove onto the disc.

Figure 1 shows Edison's original phonograph, patented in 1877, which consisted of a piece of tin foil wrapped around a rotating cylinder.

Vibration of his voice spoken into a recording horn (as shown) caused the stylus to cut grooves into a tin foil. The first sound recording made was Edison reciting 'Mary Had a Little Lamb' (Edison National History Site).

Figure 2 shows the Berliner gramophone, manufactured by US Gramophone Company, Washington, DC. It was hand-powered and required an operator to crank the handle up to a speed of 70 revolutions per minute (rpm) to get a satisfactory playback (Smithsonian Institution).

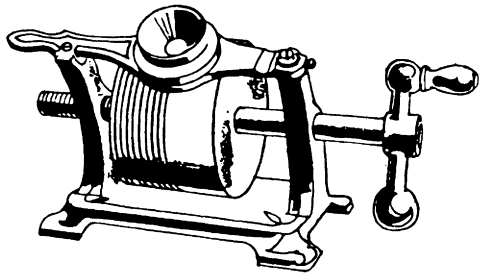

Figure 1 *Edison's phonograph*

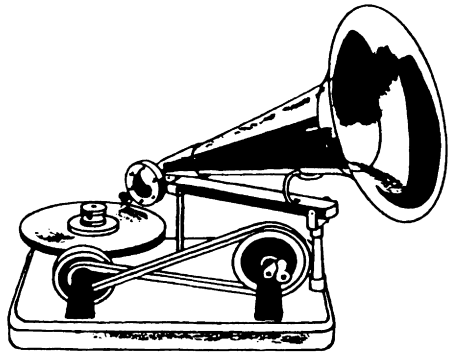

Figure 2 *Berliner gramophone*

Further developments such as the electric crystal pick-up and, in the 1930s, broadcast AM radio stations made the SP (standard playing 78 rpm record) popular. Popularity increased with the development, in 1948 by CBS, of the 33⅓ rpm long-playing record (LP), with about 25 minutes of playing time on each side. Shortly after this, the EP (extended play) 45 rpm record was introduced by RCA with an improvement in record sound quality. At the same time, the lightweight pick-up cartridge, with only a few grams of stylus pressure, was developed by companies like General Electric and Pickering.

The true start of progress towards the ultimate aim of faithful recording and reproduction of audio signals was the introduction of stereo records in 1956. This began a race between manufacturers to produce a stereo reproduction tape recorder, originally for industrial master use. However, the race led to a simplification of techniques which, in turn, led to development of equipment for domestic use.

Broadcast radio began its move from AM to FM, with consequent improvement of sound quality, and in the early 1960s stereo FM broadcasting became a reality. In the same period the compact cassette recorder which would eventually conquer the world was developed by Philips.

Developments in Analog Reproduction Techniques

The three basic media available in the early 1960s: tape, record and FM broadcast, were all analog media. Developments since then include:

Developments in turntables

There has been remarkable progress since the stereo record appeared. Cartridges, which operate with stylus pressure of as little as 1 gram were developed and tonearms which could trace the sound groove perfectly with this one gram pressure were also made. The hysteresis synchronous motor and DC servo motor were developed for quieter, regular rotation and elimination of rumble. High-quality heavyweight model turntables, various turntable platters, and insulators were developed to prevent unwanted vibrations from reaching the stylus. With the introduction of electronic technology, full automation was performed. The direct drive system with the electronically controlled servo motor, the BSL motor (brushless and slotless linear motor) and the quartz locked DC servo motor were finally adopted together with the linear tracking arm and electronically controlled tonearms (biotracer). So, enormous progress was achieved since the beginning of the gramophone: in the acoustic recording period, disc capacity was 2 minutes on each side at 78 rpm, and the frequency range was 200 Hz–3 kHz with a dynamic range of

Photo 1 *PS-X75 analog record player*

18 dB. At its latest stage of development, the LP record frequency range is 30 Hz–15 kHz, with a dynamic range of 65 dB in stereo.

Developments in tape recorders

In the 1960s and 1970s, the open reel tape recorder was the instrument used both for record production and for broadcast so efforts were constantly made to improve the performance and quality of the signal. Particular attention was paid to the recording and reproduction heads, recording tape as well as

Photo 2 *TC-766-2 analog domestic reel-to-reel tape recorder*