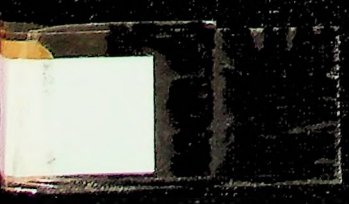
SOLID SOUND

An Analysis of the History and Development of Sound Reproduction Technology, Using Cylinders and Discs

Brian Gilmore

March 1988



THE NATIONAL COLLEGE OF ART AND DESIGN

"SOLID SOUND"

AN ANALYSIS OF THE HISTORY AND DEVELOPMENT OF SOUND REPRODUCTION TECHNOLOGY, USING CYLINDERS AND DISCS.

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BRIAN GILMORE

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Introduction

For thousands of years man has been fascinated by the mechanics of sound, and has always questioned phenomena such as thunder, snow avalanches, and of course the human voice. In the middle ages he became fascinated by the concept of a talking machine, and indeed this continued right into the Industrial Revolution. At this stage dreams started to become feasible possibilities, and by the mid nineteenth century, fascination turned to obsession, as the race began to produce the first practical talking machine.

During the course of this dissertation the most significant advances in sound recording technology are documented chronologically, and their origins and influences are examined in depth. The text concentrates on developments made in cylinder and disc technology only, and does not deal with developments made in film or magnetic tape recording and reproduction. The underlying objective is to show how and why sound recording developed as it did, and bring to light the origins of the various technologies and how they influenced each other, spanning from early experiments in 1807 to the modern day compact disc player system.

Chapter 1 The Early Developments

In 1807 the English scientist Thomas Young applied a vibrating tuning fork to the surface of a rotating cylinder and obtained a visual record of its deflection. This was the first known occasion on which a visal record had been made of sound waves for subsequent analysis. Twenty years later J.M. Duhamel a French scientist, produced a trace on a strip of paper of the vibrations of a tensioned cord. However both of these experiments were purely mechanical in nature.

Then in 1857 probably one of the most important events ever in sound recording occured. Edouard Leon Scott a French typesetter of Irish descent, built a machine which he called the "Phonautograph". This machine consisted of a barrel shaped tapered cylinder inclined at about 25^{o} from the horizontal. (See Figure 1). The narrower lower end of this cylinder was attached to a vertical paper membrane which had a hogs bristle attached to it in turn. When sound was fed into the wide end of this cylinder, the paper membrane was forced to vibrate due to a pressure difference caused by sound pulses. Consequently the hogs bristle was forced to wag, and Scott managed to record the behaviour of this bristle by placing a revolving cylinder, covered by smoke blackened paper, in contact with it. In his earlier model the second revolution of the cylinder obliterated the recorded message of the first, so his associate Koenig introduced a threaded rod, to move the cylinder laterally as it revolved thus giving a helical trace. By doing so Scott and Koenig managed to make the first human voice recording. There was however one major problem with

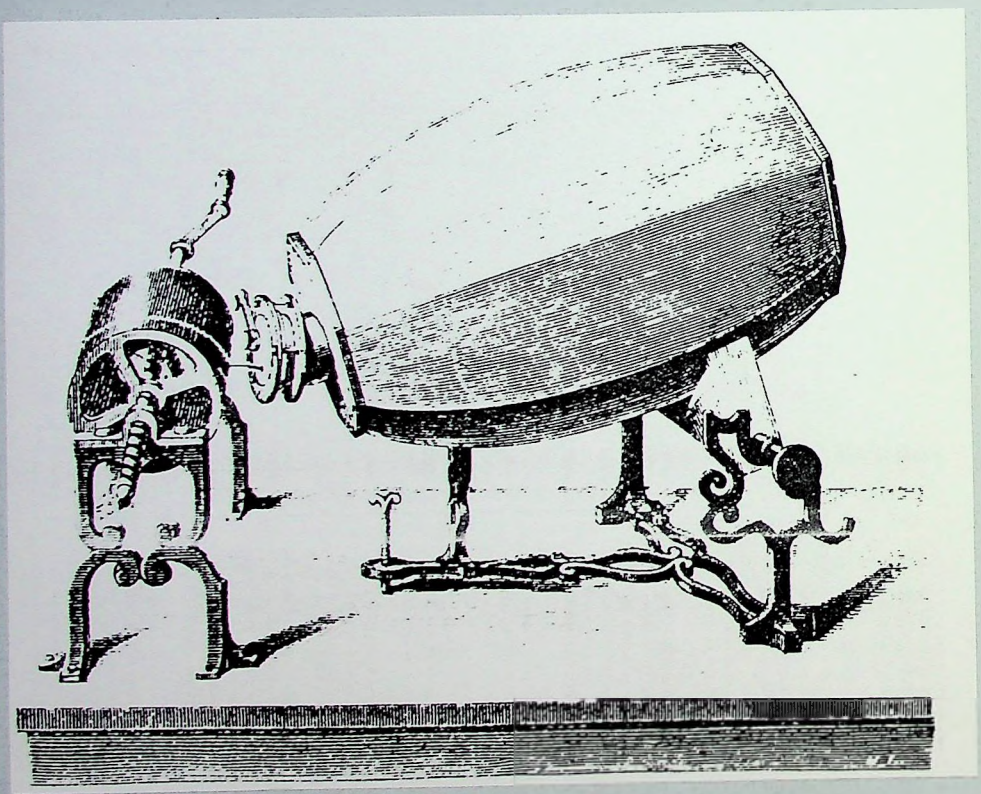


Figure 1: Leon Scott's Phonautograph from 1857.

this design; the recording was mute and incapable of being played back. This device was demonstrated in London in 1859, and was soon followed by a more advanced model, which substituted the revolving cylinder with a disc. This was the very first occasion on which a disc was used as a sound storage medium. Unfortunately it was still only capable of producing mute recordings, and nobody as yet had managed to reproduce sound.

Then in 1877, the greatest "nearly" story of all happened. In April of that year a Frenchman, Charles Cros, lodged with the French Academy of Sciences a sealed envelope containing a paper entitled "Procede d'enregistrement et de reproduction des phenomenes percus par l'ouil", in which he described his invention of a glass disc blackened with candle smoke, bearing a spiral which had been traced on it by a stylus agitated by sound waves. The spiral would be made permanent in a metal matrix by the use of photoengraving, and the sound could then be reproduced by the tracking of the engraved spiral by another stylus. Unfortunately the device which Cros titled the Paleophone" was never developed into a working design, and it was left to another inventive genius following rather different lines, to construct a working model.

The stage was ready at last for the appearance of Thomas Edison.

Chapter II Edison and the Cylinder

In 1877 Thomas Edison was heavily involved in solving the problems of storing, and reproducing sound. His patent No. 213554 applied for on February 3rd 1877, was for the design of a paper disc, on which telegraph messages could be stored for subsequent high speed transmission. Following his success with this invention Edison turned his attention to storing sound on paper tape, and succeeded in producing the very first mechanism for storing and reproducing sound. (See Figure 2). In simple terms the paper tape was folded to form a ridge along its length. The peak of the ridge or knife edge as he called it, was indented via a diaphram, by means of a stylus with a chisel-shaped point, as the paper was driven across a revolving drum. To reproduce the sound the tape was fed via another revolving drum, past a similar stylus, which in turn was connected to a reproducing diaphram. By the time the invention became public news in November 1877, Edison had already turned his attention to the revolving cylinder of Scott's phonautograph. In December of that year the first tin foil phonograph to be demonstrated outside Edison's workshops, was taken into the editor's office of "Scientific American", and in the words of the article printed in the December 22nd issue of that jopurnal, appeared the following.

> "Mr Thomas A. Edison recently came into this office, placed a little machine on our desk, turned a crank, and the machine enquired as to our health, asked how we liked the phonograph, informed us that it was very well and bid us a cordial goodnight."

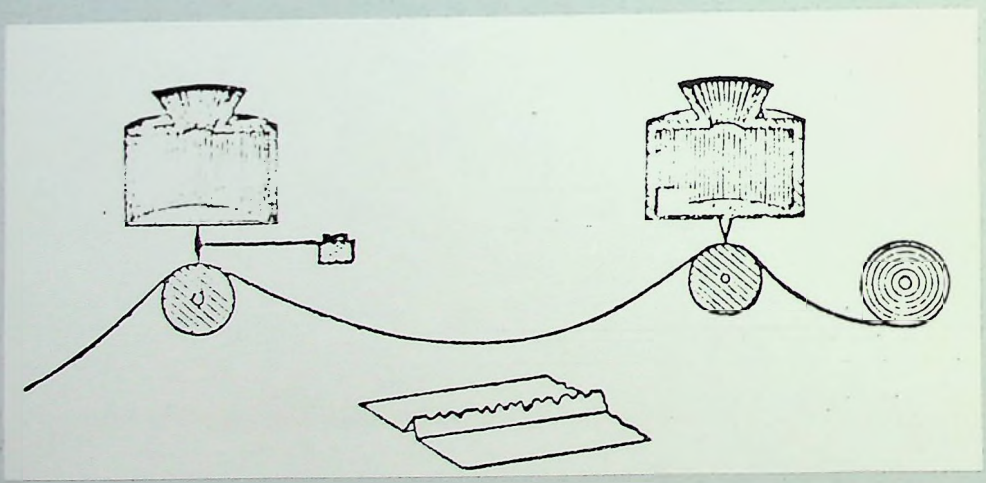


Figure 2: Thomas Edison's paper tape recording system.

Two days later on December 24th 1877 Edison filed his invention at the patent office. This particular machine (Figure 3) had been built by John Kruesi, from Edison's primitive sketches (Figure 4) and verbal instructions, and was completed on 6th December 1877. The machine consisted of four main components.

1. The "Phonograph", which was a mouthpiece connected to a diaphram from the centre of which protruded a stylus.
2. A grooved brass cylinder about 4in in diameter, mounted on a threaded shaft which was turned by a small hand crank.
3. A sheet of tinfoil coated the cylinder, and when indented with a recording, this foil was called a "Phonogram".
4. The "Phonet", a reproducing unit comprising a metal point held against the tin foil, by a spring and attached to a secoond diaphram.

This very first phonograph had a playing time between 1 1/2 and 2 minutes, dependent on the speed of cranking.

Now that Edison had achieved a method of reproducing sound, he founded the "Edison Speaking Phonograph Compnay", on January 24th 1878, and began leasing out machines on a quarterly basis together with a supply of tin foil blanks. He had hoped that these machines would stimulate great interest in business circles, for recording short messages but alas could not have been more misled, when office managers proved by their lack of interest that they could exist perfectly well without the use of phonographs. Thus by 1879 the phonograph had become nothing more than a glorified toy, and it appeared as if its short but sensational life had come to an end.

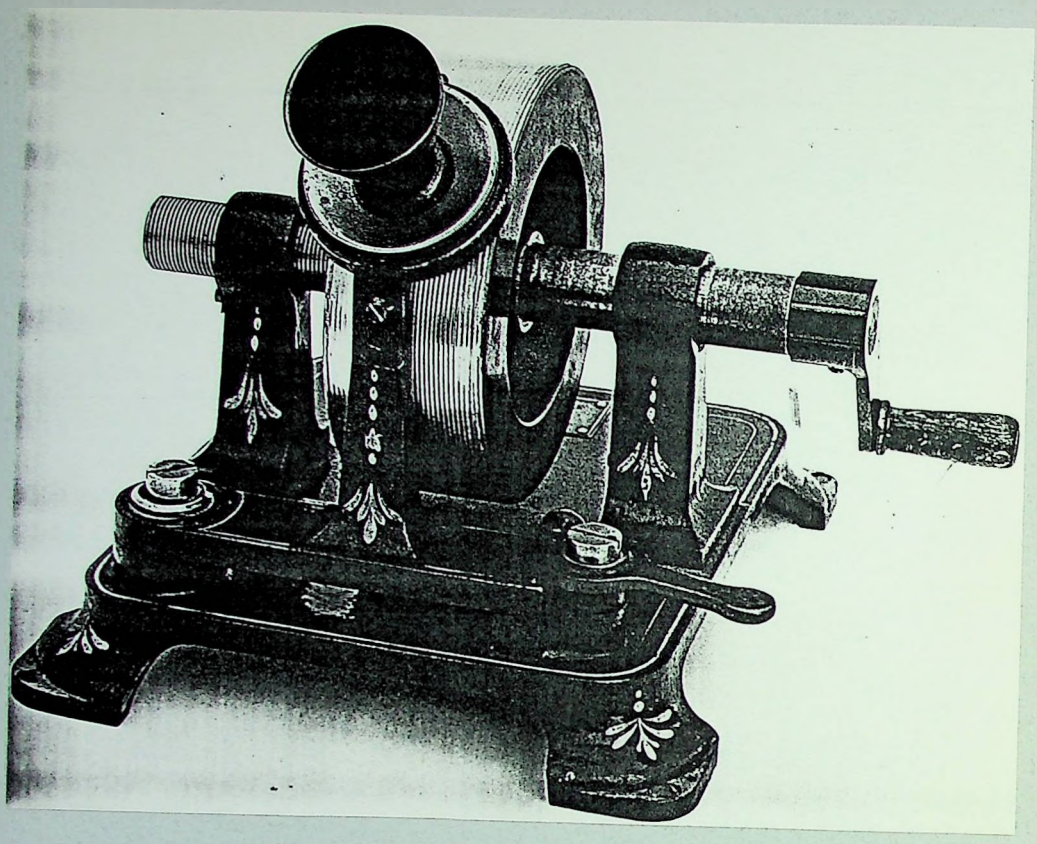


Figure 3: This was one of Edison's early tinfoil phonographs.

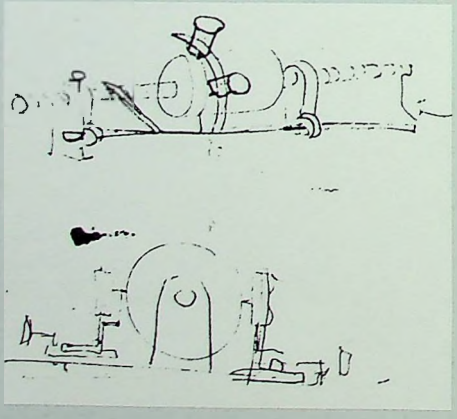


Figure 4: Edison's primitive sketches from which John Kruesi built the first phonograph.

However other minds were working hard to improve the phonograph, and in 1880 Alexander Graham Bell opened his volta laboratory in Washington D.C., with the specific aim of continuing research into both his own invention: the telephone, and the phonograph, the latter receiving the most attention. Bell worked with his English cousin Chichester Bell, and his associate Charles Tainter, and between them in 1881 they came up with a solution they called a graphophone. This device was almost identical to Edison's with one major difference. The tinfoil cylinder was replaced by a hard wax cylinder. For the next four years work upon the improvement of the graphophone continued, and culminated on June 27th 1885, with the application for a patent covering the following modifications. The was coated cylinder was replaced by a wax coated cardboard tube, designed to fit over a spindle; the stylus assembly was flexible whereas Edison's was rigid; and this assembly travelled the length of the revolving cylinder, rather than the cylinder moving sideways under it. (See Figure 5.) This technology had one major advantage over Edison's earlier invention; the sound quality was much better because the groove was cut into the wax rather than indented or embossed as was the case with Edison's design.

Rather than go into direct competition with Edison the Bell Tainter partnership decided to approach him personally, and proposed an amalgamation of resources to continue the development of the talking machine. Predictably Edison refused to swallow his pride and was absolutely outraged by the sheer cheek of such a proposal. Instead he went his own separate way, and carried Bell's development one step further, by developing

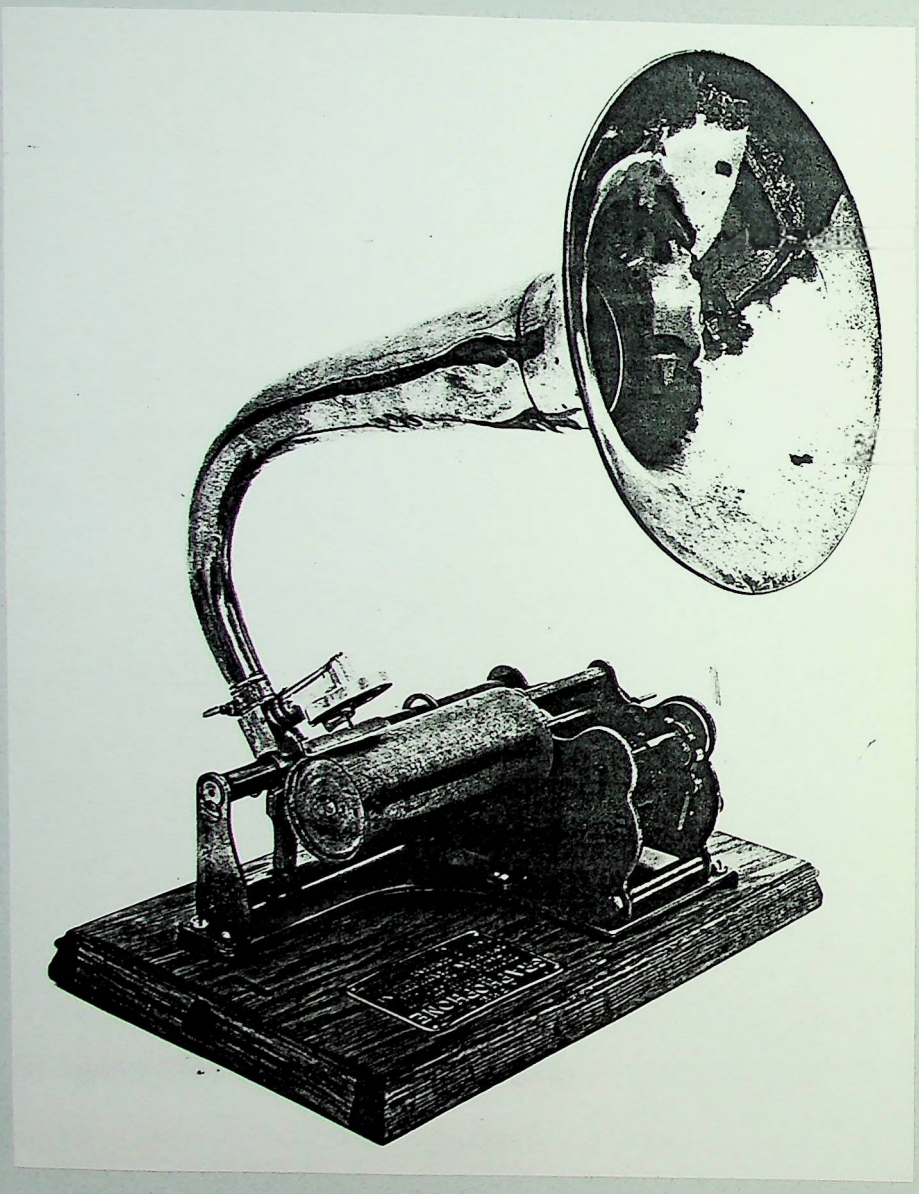


Figure 5: An early graphophone

a device capable of erasing wax cylinders so that they could be recut. (See Figure 6). The result of this action was two companies, Edison's "Phonograph Company", and Bell's "American Graphophone", going into direct competiotion in the same market. An American business tycoon, Jesse Lippincott realised the destructive action this rivalry would cause, and so by some highly skilful wheeling and dealing brought the two companies together as the "North American Phonograph Company", founded on July 14th 1888. One year later the wax cylinder was launched commercialy at the Paris Exposition.

At this stage all cylinders were individually cut which made them extremely expensive and rare. However on March 18th 1892, the first duplicated recordings were produced. Up to 150 copies could be taken from each master cylinder by a form of dubbing. This event signalled the start of high volume commercial recording. This coupled with the invention of clockwork powered cylinder players which retailed at about $ 75, meant that cylinders and cylinder players were becoming more affordable to the generla public. The next step forward in the development was the introduction of moulded cylinders, the first of which were produced by the Lambert Company of Chicago early in 1900. These were followed by Edison's "gold moulded" cylinders in 1901. Early cylinders were moulded in celluloid, Edison's designs being capable of being played on a wide range of his cylinder players. One such model can be seen in Figure 7. This design was purely functional in nature, and styling was giving a very small amount of consideration if indeed any. It has some extremely interesting features. For example the box in which the clockwork mechanism is housed

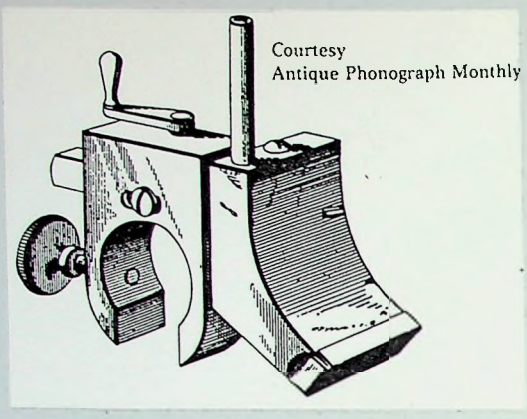


Figure 6: Edison's cylinder eraser.

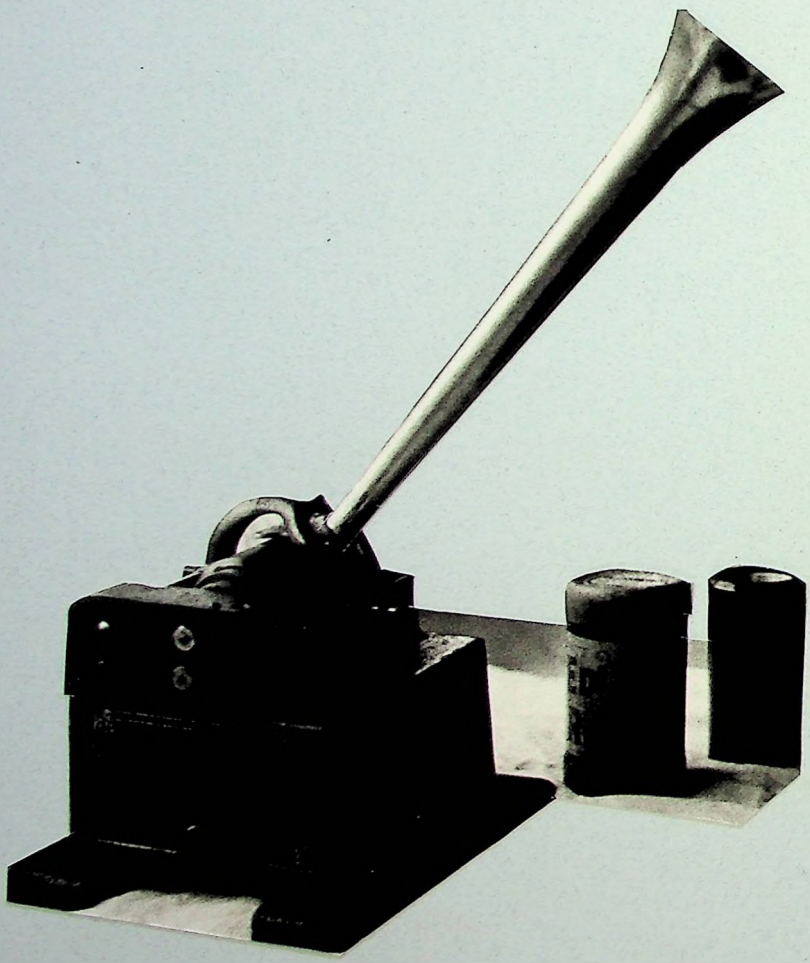


Figure 7: An Edison cylinder player from 1901.

is made strangely enough from cast iron, which makes the whole item extremely heavy and stable. The two feet on which it stands are made from a hard wood and the rather elegant slim-line horn is polished brass plated tin. One very interesting point about this design is the quality of sound it produced. Even after 87 years, the example examined still produces a terrific quality sound. The stylus is very easy to change and the cylinders are incredibly enduring, having a much better tolerance for heat and physical abuse than modern day discs. However by 1901 the system which Edison had put so much time and effort into perfecting, had a very clearcut competitor, which was eventually set to take over the cylinder phonograph market coimpletely. This was of course the disc gramophone pioneered by Emile Berliner.

Chapter III Berliner and the Disc

While Thomas Edison was working franticly to produce a sound reproduction system, Emile Berliner was seeking methods to improve Alexander Graham Bell's telephone, and in 1877 he applied for a patent for a carbon button transmitter. He had great difficulty in getting the patent rights, and in fact the patent was not granted until 1891. However while waiting he interested the Bell Telephone Company in his invention, and in 1878 he sold it to them for a large sum, which included a retainer fee on a monthly basis, which enabled him to coninue his research. Then in 1881 Berliner as it were, took the money and ran back home to Germany, where he and his brother Joseph set up "Telephon-Fabrick", to provide telephones for the German market. This proved to be an extremely lucrative venture, and enabled him to return to the U.S. after just two years and address his energies and knowledge solely to the recording and reproduction of sound.

From the outset Berliner concentrated on using the lateral method of tracing sound vibrations, as suggested by Scott's later phonautograph, and Charles Cros' research i.e. lateral disc recording. Four years of determined experimentation eventually produced a solution for which he applied for patents in Germany, the U.K., and the U.S.A. on September 26th 1887. Thus the name "Gramaphone", (Figure 8), meaning a talking machine using lateral cut discs, as opposed to the "Phonograph" of Edison which used vertically cut cylinders, was registered in all three countries. Then on May 16th 1888, the first public demonstration was made before the Franklin Institute in Phila-

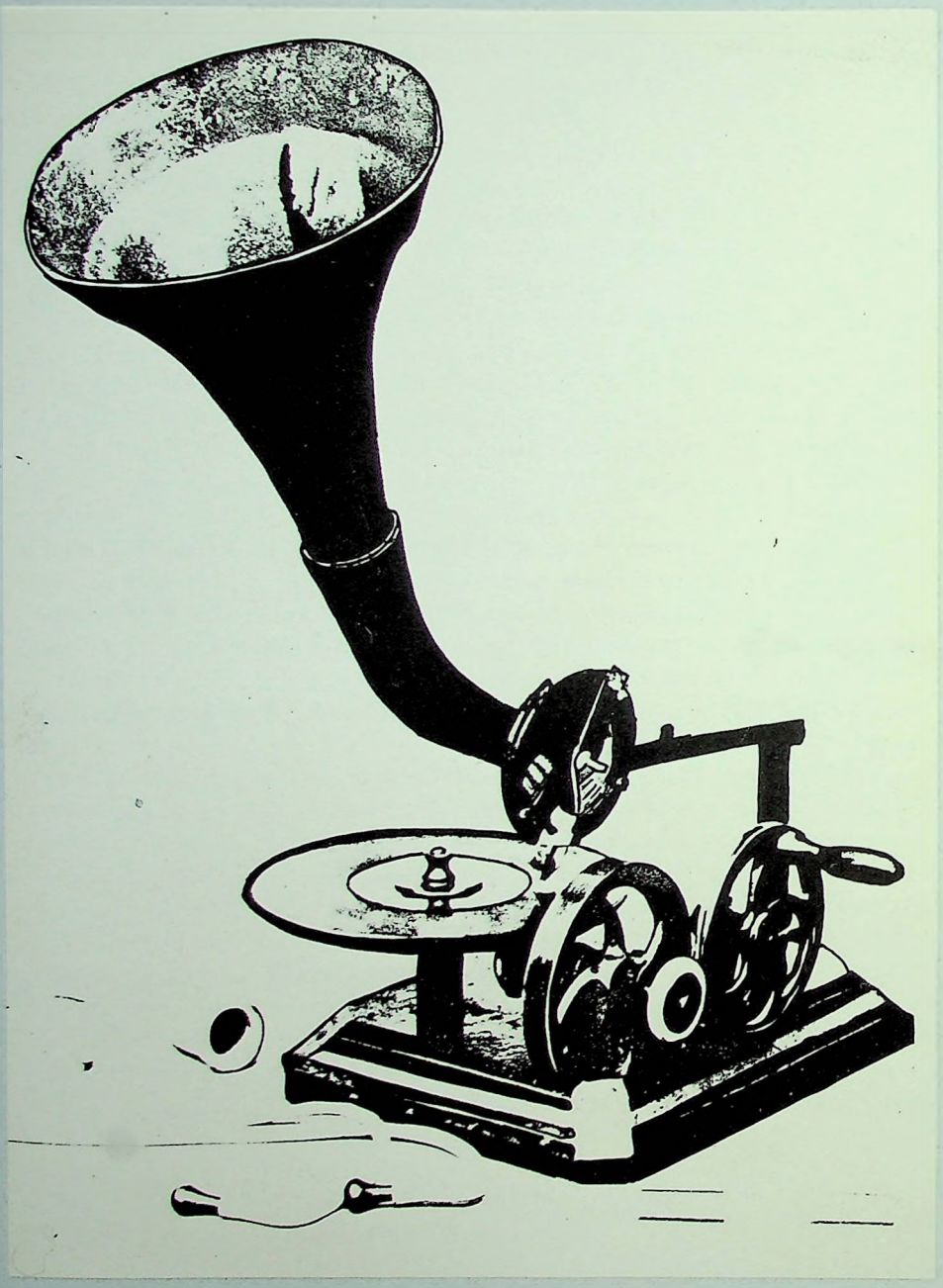


Figure 8: Emile Berliner's first ever gramophone, designed in 1887..

delphia. Berliner however on the launch of his new invention, endeavoured to aim it toward the home entertainment industry, rather than toward the Edison market: "the business sector". He had hoped that the possibility of mass producing records cheaply from one master disc, would spur contemporary artists to record, in the hope of amassing new fortunes from royalties. Nevertheless the sound quality produced by these pioneer works of Berliner, was not good enough to draw artists in large numbers to record at his studio.In fact all he managed to do, was to get a German toy merchant namely "Kainmerer and Reinhardt" to market his products as novelties for the Christmas trade, and as a result the appeal of the invention began to wear off, until by 1893 demand had dropped to abysmal depths.

During this lean period, Berliner's Gramophone Company had enlisted the services of a young American engineer, named Eldridge R. Johnson, who ran a small machine shop in Camden N.J. Johnson developed the first clockwork powered gramophone in late 1895, using his earlier sewing machine motor, and by doing so saved the day for the gramophone. Berliner put Johnson's new invention into production almost immediately, and by doing so sparked off an unprecedented interest in the marketplace. The first machine to be produced (Figure 9) played 7 inch vulcanite 70 rpm discs, and sold for a mere $ 25. This particular machine could be bought for 1/3 of the price of a contemporary cylinder player, and discs were also available for a fraction of the cost of cylinders, So as early as 1895 Edison's design was already under severe pressure in the marketplace.

Figure 9: Berliner's first clockwork gramophone sold for $25 in 1895.

Then in 1898 two further developments helped to make disc gramophones available to an even wider mass market. Record presssing became a highly commercial venture, with the first factory solely devoted to record pressing being set up by Joseph Berliner in Hanover, Germany. (By 1908 this factory was turning out 6.2 million discs a year). Coupled with this the National Gramophone Company in the U.S.A. started selling gramophones on hire purchase, at $ 5 down and $ 3 a month for seven months. These events meant that by 1902, Edison's new machines were under incredible pressure in the marketplace. In fact his alliance with Bell's Telephone's Graphophone Company broke up, and the first disc playing graphophone appeared in 1902. (See Figure 10). In conjunction with this Columbia records introduced recordings in parallel disc and cylinder in the same year, and in the following year they launched their "Grand Opera" series in disc format only. Obviously Edison was a little more than unhappy with these developments, as the disc gramophone had been broken into the market, and soon began to dominate. However he refused to be converted and continued to produce phonographs until 1911. Figure 11 shows one of the very last phonographs to be produced by him, and demonstrates very effectively how he tried to be competitive by using neat attractive styling. In this example the functional parts are sculpted to blend visually with the tone horn and give a more complete visual appearance. In sharp contrast to this model, the early gramophones were rather crude and completely functional in nature, if we examine Figures 9 and 10 again. Contemporary models were also rather crude looking, and were still greatly inferior aesthetically to Edison's 1911 design, if we consider the "American Victor

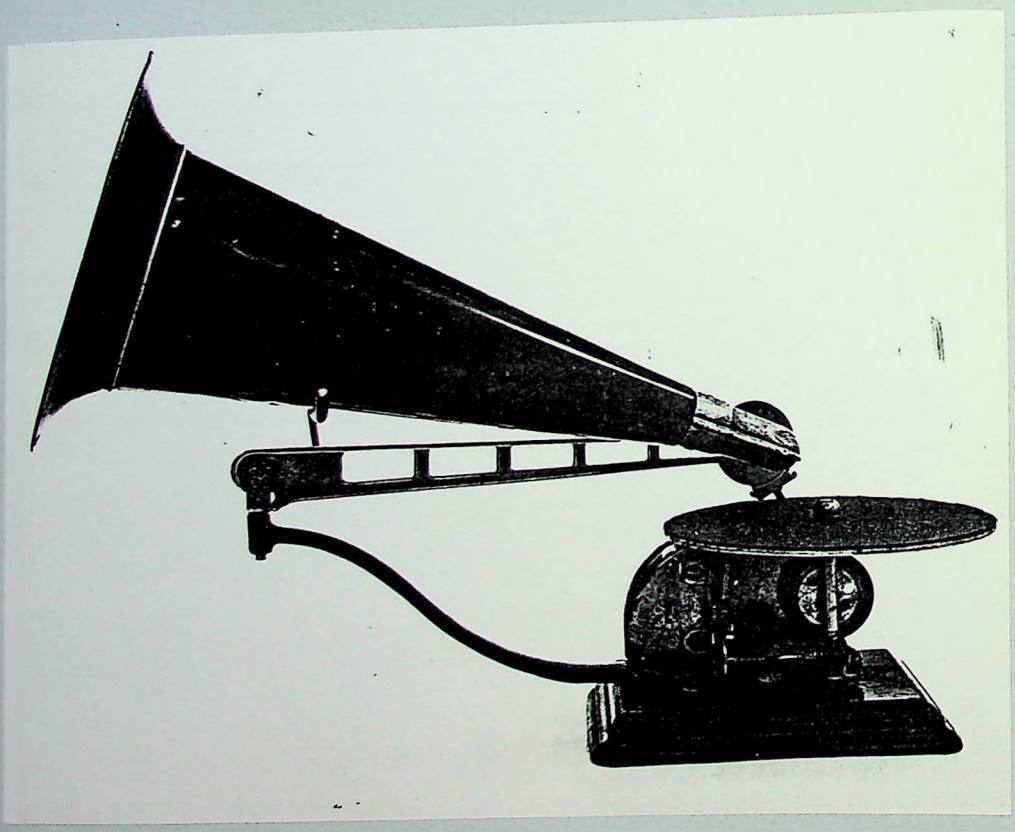


Figure 10: The Graphophone Companie's first disc playing machine in 1902.

Figure 11: The Edison "Grand Opera" phonograph of 1909.

1 Gramophone" in Figure 12. This machine dates from 1909 and looks rather clumsy and ugly when compared to Edison's Opera Phonograph (Figure 11).

Gramophone design started to change in 1909 with the emphasis being on the eradication of the rather clumsy overhead horn. One of the earliest and in fact most interesting departures was the pleated diaphram speaker model, designed by Louis Lumiere in 1909 (Figure 12). Here the designer used a large paper diaphram attached directly to the pickup stylus to produce the sound. This particular design as well as presenting a totally new look, was the direct ancestor to the moving coil speaker developed in the 1920s, and ironically was not offered to the public until 1924 when HMV marketed it.

However in the meantime concealed horn gramophones became the main subject for developement, and these consisted of two main types:

1. Conical metal horn types, which were exactly the same as their predecessors except for the fact that the horns were brought under the turntable and stored in a cube-like box.
2. Cardboard or wooden funnel types.

At the early stages of development Pathe brothers were the leaders, producing some rather interesting models. Figure 13 was one of the earliest concealed horn gramophones, but as can be seen was rather crude in appaearance. Figure 14 was however one of the most important developments of the era. This was their famous "Vertical disc" record player. It was provided with a large cardboard funnel on the end of which was fixed a saphire needle. This particular model possessed a

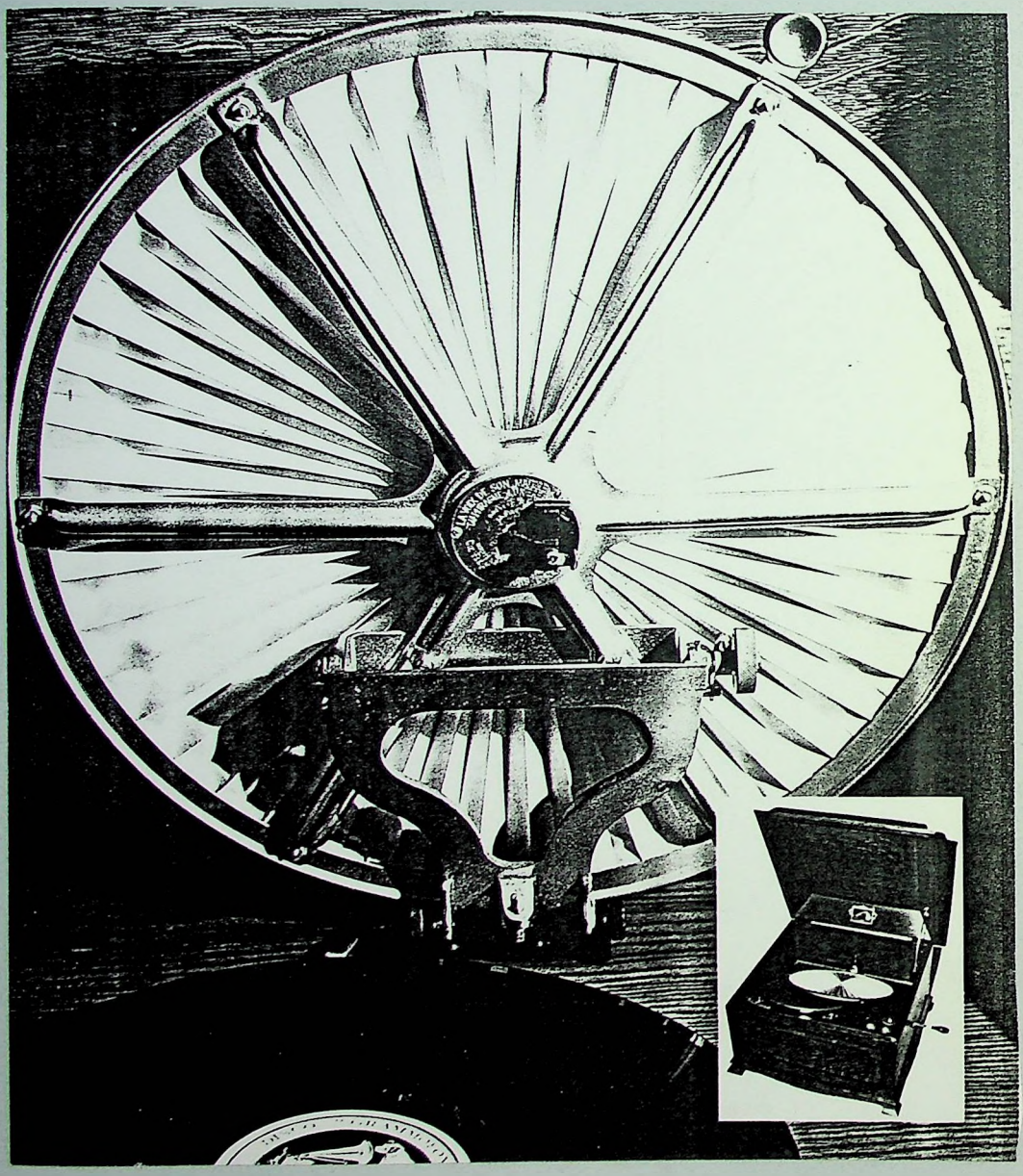


Figure 12: Louis Lumier's pleated diaphram speaker design of 1909.

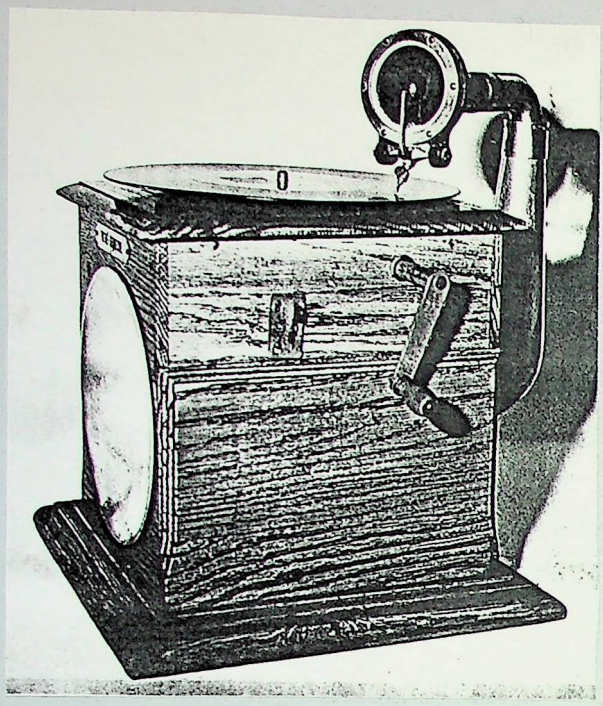


Figure 13: Pathe concealed horn gramophone designed in 1909.

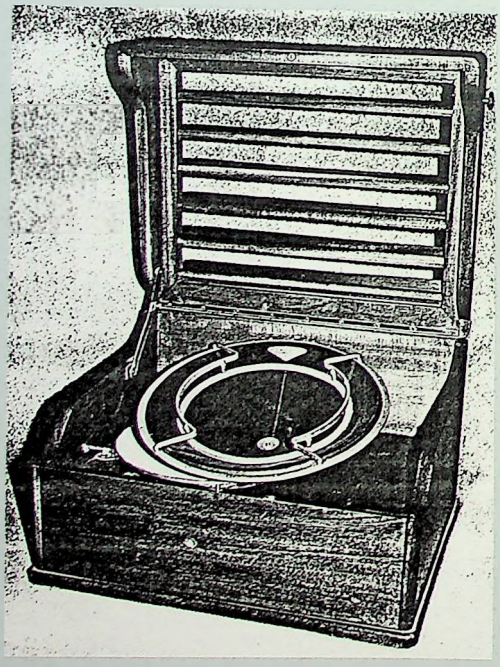


Figure 14: The Pathé "vertical disc" record player from 1910.

totally new feature in that sound volume could be controlled by the movable shutters. Between 1910 and 1911 Pathe developed another model, which had an internal wooden soundbox which worked on similar principles to guitar and violin soundboxes, but again this was rather box like and lacked visual appeal (see Figure 15). Pathe were closely followed by HMV and of course Edison who decided at last that it was time for change, and in fact he managed to pull off yet another coup in 1916 by producing a gramophone capable of playing all types of discs. This model (Figure 16) had an interchangeable pickup system, and was designed specifically for entertaining American troops in active service during World War I.

By 1920 acoustic recording and reproduction, had developed almost as far as possible, and further development in sound recording needed to go beyond the capabilities of acoustic techniques, which were only capable of capturing sound between 164 and 2088 Hz, The way forward lay in electrical recording which shall be discussed later on.

However before we move ahead, two very significant developments took place at the turn of the century, which were to have a major impact later. In 1903 Sir Charles Parsons invented the very first amplifier. This device was called the Auxetophone, and was described in its patents as being suitable for use with phonographs, gramophones, telephones, musical instruments and resonators. (See Figure 17). It was very useful for amplifying records inlarge halls, but was totally unsuitable for use in domestic / household applications, because of the annoying hissing sound it produced. As a result it was

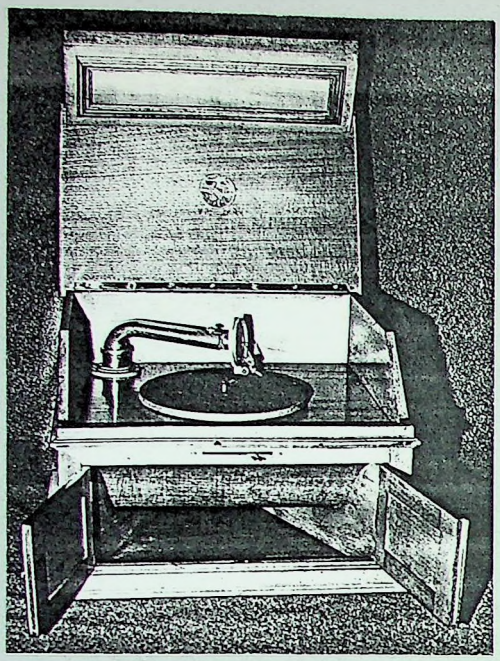


Figure 15: Pathe sound bot model from 1911.

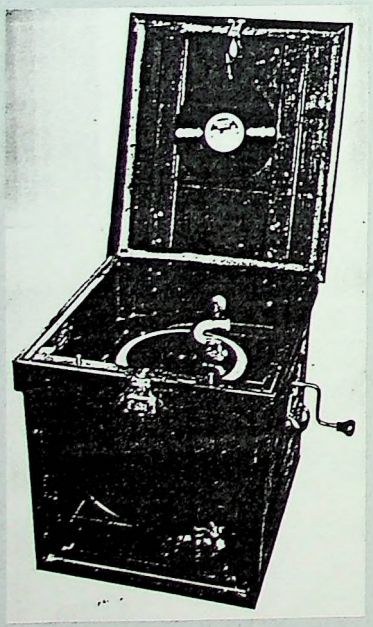
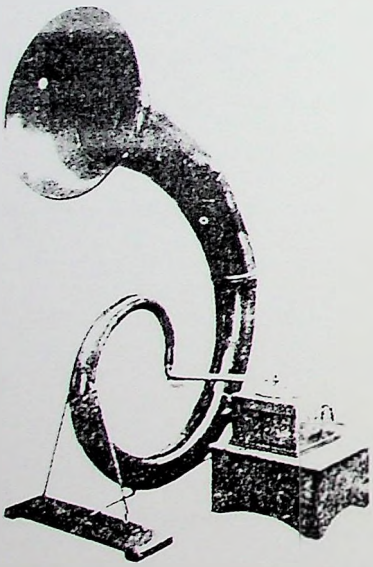


Figure 16: The "Edison phonograph companie's" gramophone of 1916. This machine had an interchangeable pickup system.

shelved for future development. The other significant invention of this time however, was much more influential later on. This was the electron tube or valve amplifier, developed by Lee De Forest in 1905. It was this particular invention which made possible the lightning fast development in sound reproduction which was to come.



The Auxetophone compressed-air amplifier.

Figure 17: The Auxetophone: The first acoustic amplifier, designed by Sir Charles Parsons in 1903.

Chapter IV Electrical Recording

The use of electricity in both recording and playback made its first appearance in 1920. Up to that time recording was a very uncomfortable experience for everybody involved as groups of musicians had to huddle quite closely to the recording horn. Recording engineers had the nightmare task of calculating how close to, and at what angle to the recording horn musicians should be positioned, in order to achieve decent results. Consequently good records relied a lot more on good luck than good recording management. The adaptation of one invention solved all of these problems; the microphone.

The very first microphone was the electromagnetic telephone trasnmitter developed by Alexander Graham Bell in 1876. This device was further developed by Emile Berliner, in his carbon trasnmitter the following year. For some unknown reason this technology existed for some fifty years before it was used in recording, and somehow managed to escape the attention of both Berliner and Edison. The first people to use the microphone in sound recording, were two engineers employed by the Gramophone Company, George William Guest and Owen Merriman.

Guest and Merriman were commissioned to record part of the burial service of the unknown warrior, at Westminster Abbey on November 11th 1920. They realised that on such an occasion, they would not be allowed to mar the solemnity of the event, by fussing over bulky, ugly, noisy equipment, and so had to find a new way of doing their job. To achieve their aim, they rigged up a makeshift microphone, a silent and inconspicuous

object in the vastness of the great hall, and subsequently relayed the signal via a telephone line to their mobile studio in a van parked in a nearby street. In this studio, the signal was fed to a cutting stylus via an electromagnet, and hence produced the first electrical on location, or live recording, The double sided 12 inch disc produced was sold for 7s 6d by the Times newspaper.

During the same year HMV built the first record autochanger, from plans of Eldridge R. Johnson. This machine was built by an engineer called Tomsett, and was the world's first electrical gramophone. It played five discs in succession, rejecting each after it had been played, but was not offered to the public.

In theory electrical recording offered considerable improvement on contemporary acoustic recording, but record companies were quick to realise that current acoustic players were unable to do justice to electrical recordings, so they arranged a pact to keep the general public in the dark about the advantages of the new techniques, and also instructed the press to disclose very little information. The word adopted for the new system by English Columbia was "stereoscopic", and was apparently coined to confuse rather than enlighten. Obviously the secrecy was meant to prevent faithful customers from thinking that their equipment and records were out of date, which in fact they were.

By 1924 record sales started to decline for all the major companies involved, so something new was required by the industry

to stimulate the market again. The obvious solution was a full launch of electrical recording and reproduction equipment, but AT + T were planning to patent the electrical recording principle, and licence a monopoly to the first customer. This caused a big scare in the industry, and led to an intense period of negotiation, after which all the major companies involved reeceived permission to use the technology under licence. The electrical race was on and consequently the public became aware of the obsolescence of acoustic recordings and reproduction systems. The marketplace was now ready for the introduction of electric record players.

The first all electric instrument offered to the public was Brunswick's "Panatrope", which appeared in the U.S. in 1926 at $ 350 and up. This machine consisted of a direct drive turntable, fixed coil cartridge / stylus assembly, electronic valve amplifier, and a massive moving coil diaphram speaker. The Panatrope only played one disc at a time, but was closely followed by Victor's autochargers in 1927. This machine was developed from the experimental Johnson / Tomsett model of 1920. The first autocharger marketed in the U.K. was made by Garrard in 1932. Garrard failed to become a hugely successful company, but they developed the first player capable of tracking both sides of a record without turning it over in 1938. The point of interest here is that in 1981, Sharp announced their VZ 3000 model dual play disc compo system, claiming it was the world's first disc player to do what the Garrard model had done 43 years earlier. (Sharp's player held the disc vertically, and tracked it with twin linear arms.) From 1927 the autocharger with tangental pickup arm, was

viewed by record player manufacturers as the way forward, and indeed development continued on improving its design up until 1971 when they were eventually discontinued.

In 1929 disaster struck in the U.S.A. in the form of the Wall Street crash, and as a result the market for records and players flopped there. The situation was not quite as serious in the U.K., but the depression began to bite in the early 1930s and the market began to fade, the net effect being that domestic record player manufacture was shelved, and did not regain its momentum again until the aftermath of World War II.

In 1930 Columbia refused to be put down by the depression, and developed the first records with run in grooves, in an attempt to woe their now poorer customers with yet another novel idea. Unfortunately for them the market did not respond, and by 1933 the American record industry was in huge trouble, not knowing which direction to go. Then in December 1933 Prohibition was lifted and people enjoyed greater freedom once again, and as a result the saviour of the American record industry appeared; the jukebox (Figure 18). Thanks to these machines record sales mushroomed, and the industry was extremely healthy in the U.S. in 1942.

Incredibly it was not the second World War that slowed the record industry down in the U.S.A., but rather a strike by the American federation of musicians, demanding a bigger share om the constantly rising cake. This strike lasted 27 months during which recording came to a virtual standstill.

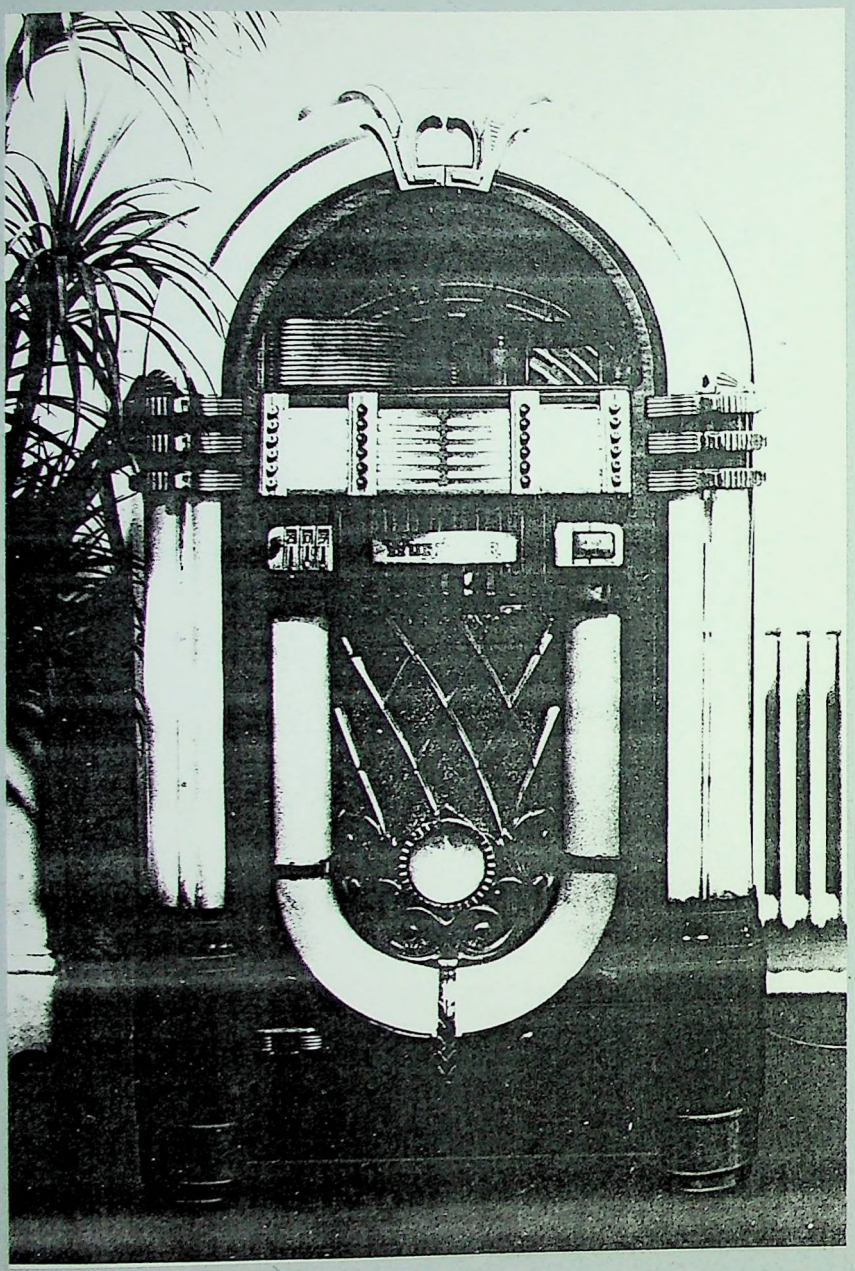


Figure 18: Wurlitzer Jukebox from 1933.

The situation in the U.K. was however totally different. Technology was advancing due to the war, and in 1940 the war department asked Decca to develop a system of recording, sensitive enough to reproduce the subtle difference between the sounds of British and German submarine engines. These recordings were required for the training of personnel operating listening devices. Decca's engineers under the direction of Arthur Haddy, tackled the problems. The requirement was for a recorded frequency range reaching reliably up to 12 KHz. Haddy and company managed in fact to record sound at 14 KHz, thus widening the spectrum of sound recording considerbaly. Consequently after the war, Decca marketed new recordings with the advertising slogan, "full frequency range recording", or ffrr.

The war adversely affected record manufacturing, because it created an acute shortage of materials, especially lac from India, a vital ingredient in Shellac. In fact lac supplies were totally cut off. Furthermore demand for records in the U.K. was also affected by the introduction of 33 % VAT in 1940 in order to fund the war effort. This put records out of the means of most people until the end of the war. The shortage of lac though, was the most serious problem of all. When supplies ran out old discs were ground down and new ones were pressed from the recycled material. This recycling process however posed a new problem, in that the hissing sound traditionally associated with Shellac discs, was made even worse, and a new material was urgently required by the industry if sound quality was to be improved. This new material vinyl did not appear though, until 1957.

As mentioned earlier, autocharger design was shelved until after the war, and in fact one of the first post war models can be seen in Figure 19. This was the famous PYE black box, one of the earliest record players sold in Ireland. It comprised of a flip-top black box, in which was housed a B.S.R. turntable, PYE valve amplifier and a pair of rather large speakers (Figure 20), which were present to give a "fuller" quality sound. This machine performed relatively well but had one major drawback; a roaming tone arm, which tended to streak across record surfaces without warning. These early black boxes were blamed for ruining many a good record collection. A much better solution was presented in the form of the model shown in Figure 21. This was Audio Fidelity's autocharger of 1952. Though still very box-like, it looks more visually balanced than its PYE predecessor, and in fact showed a big improvement in performance.

Autocharger design continued to develop during the 1950s and considerable improvements were made in turntable, and tone arm design. This was of course spurred on by the introduction of stereophonic vinyl discs in 1957. The next example we are going to look at is again a Fidelity design and dates from 1964. This particular model has an automatic turntable /tone arm mechanism and (Figure 22) incorporates a cartridge - stylus configuration capable of playing both mono and stereo discs. It is also capable of playing 33, 78 and 45 rpm discs. This particular model was designed to be portable and carries like a briefcase. This was a very common feature in design of the 1960s. When we look at its styling, one aspect stands out and that is the use of chrome on the control panel. This was

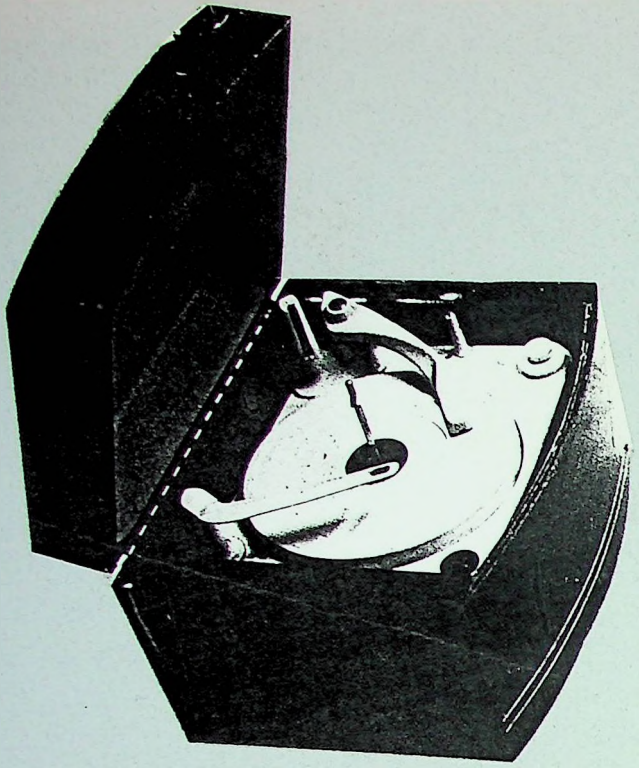


Figure 19: The famous Pye "Black Box" designed in 1949.

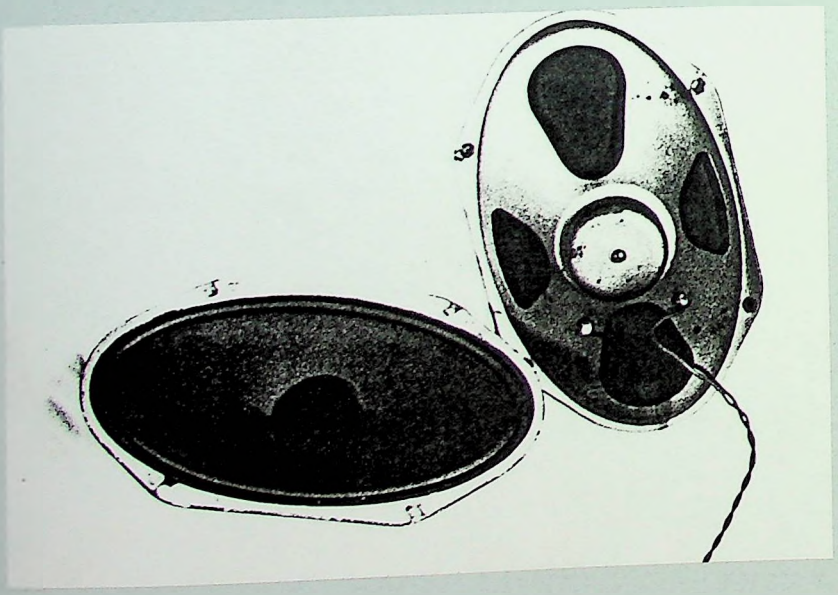


Figure 20: The speaker set used in the "Black Box".

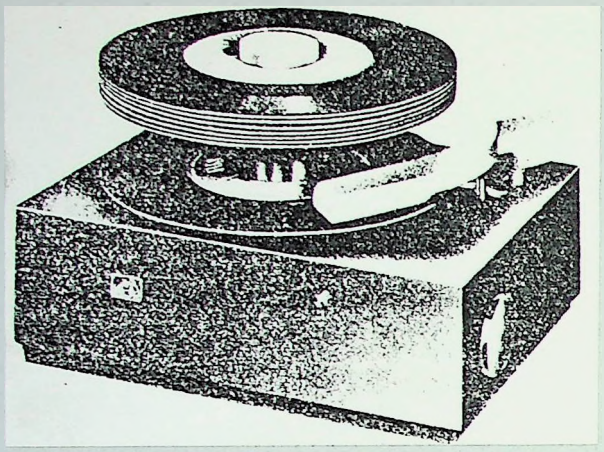


Figure 21: Audio Fidelity autocharger of 1952.

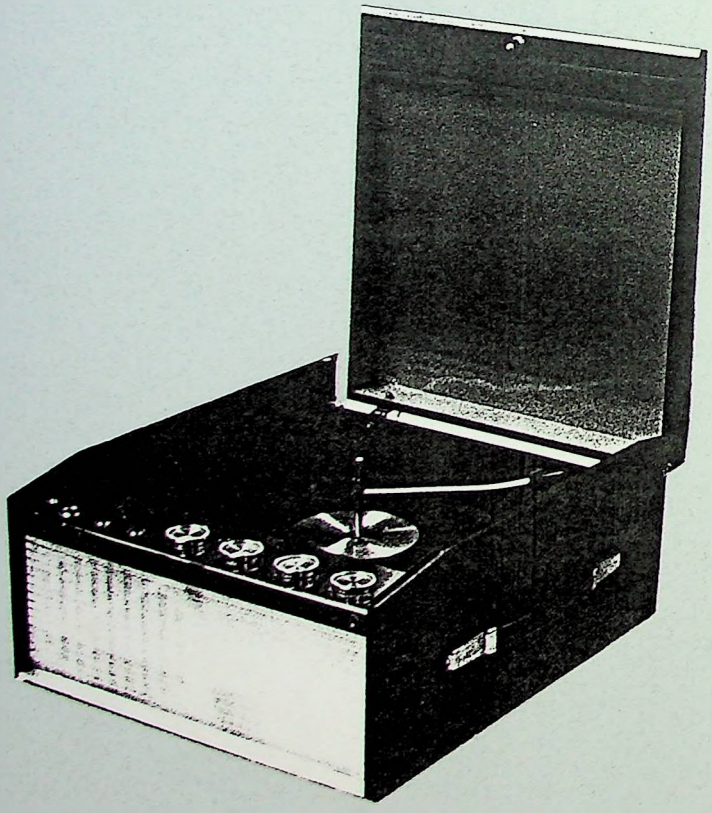


Figure 22: Fidelity autocharger design from 1969. This machine was capable of playing both stereo and mono discs.

extremely well fabricated and in fact the chrome does not wear off like one would expect it to during prolonged use. The lettering printed on this chrome is also extremely durable and in fact, the cabinet in which the unit is housed is capable of withstanding quite an amount of abuse. This design had however one major drawback in that it was not dust proof.

Fidelity continued to produce autochargers until 1971 and in fact the very last model they produced can be seen in Figure 23. This was basically the same as the previous example except for the fact that it used a transistor amplifier, instead of the earlier valve type. 1971 saw the end of the autocharger era and further development concentrated on stereo component systems, and three in one music systems. By this stage the stereo era was in full swing.

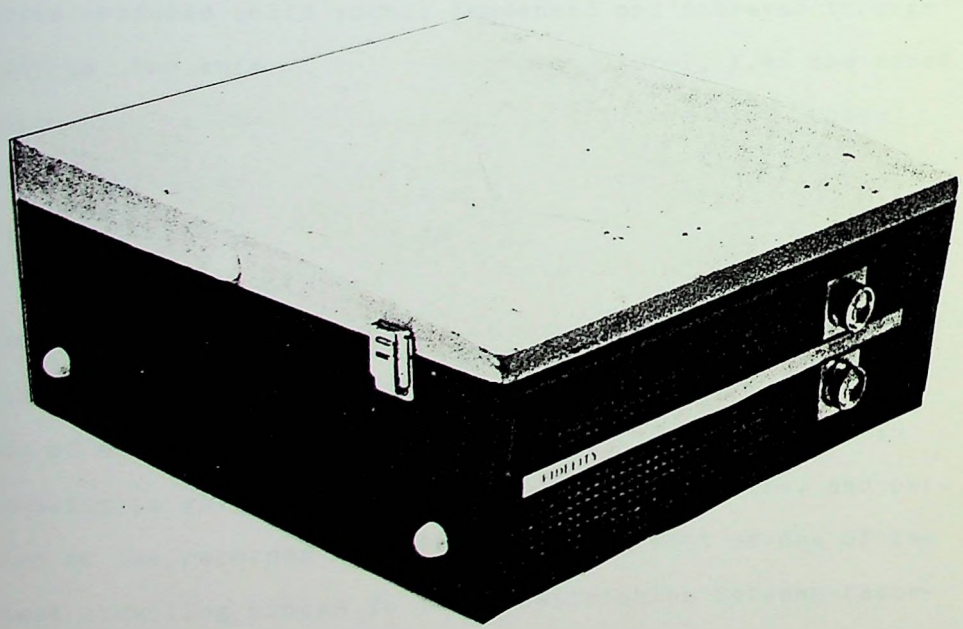


Figure 23: Fidelity's last autocharger marketed in 1971. This model was one of the first to use a transistor amplifier.

Chapter V The Stereo Era

Stereophonic sound came into the mass-market on a large scale, somewhere in the 1960s and got its greatest boost from the rock / pop revolution. However it had been around for quite a while by 1960. The word stereophonic itself is derived from the Greek "stereos" = solid and phone = voiced, and is meant to indicate a method of sound reproduction that gives the listener an illusion of spaciousness, by conducting the sound to the ears through two different paths. In its simplest form, stereo arbitrarily channels the individual voices of a group of artists into two routes, one on the left, the other on the right. In fact a less appropriate word than "solid voiced" could scarcely have been used. The word "stereo" should have been applied to the older system which was for all practical purposes produced solid sound, condensed and conveyed through one source. For this method the word monoaural, i.e. one eared was coined to distinguish if from stereo. This word subsequently changed to monophonic, and is known today simply as mono.

The value of stereophonic sound is not as the popular misconception tends to indicate, in its ability to split up the sounds of artists into their component parts, but rather in its ability to give an illusion of depth, atmosphere, and perspetive to the recorded sound. This is the root of one of the greatest stumbling blocks in the relationships between recording engineers and musicians. Musicians use stereophonic sound to create illusion, and perspective in their artwork (a good example being the Apollo series, composed and performed by

Brian Eno and Daniel Lanois). However what very often happens in the recording industry, is that the recording engineer gets the upper hand in the cutting and mixing of a record, and totally obliterates the effect sought by the artist, in the pursuit of technical excellence, i.e. high fidelity sound. To illustrate this difference, if one listens to Paul Young's "No Parles" LP, and compares it to the forementioned Eno composition, one will notice a major difference. Eno is trying to take advantage of the stereo effect whereas the other LP is engineered to look balanced on your midi or rack system, and in fact puzzles you as to where the sound is coming from, rather than stimulating your mind to paint a picture, as it were.

Getting back to the history, the first demonstration of stereophonic sound was made in 1881, at the Paris Exposition, by Clement Alder, using two telephones, and subsequently the very first stereo records and reproduction machines were produced in Paris by Pathe shortly before World War I. The discs used by Pathe were very interesting in their design. They were centre start, (now used in CD players), and bore two parallel grooves, one carrying the left channel, the other carrying the right (see Figure 24). Playing these discs must have been somewhat of a nightmare though, because each track had its own starting point and had to be tracked by its own pickup arm. (See Figure 25 for the first Pathe stereo player). The net effect being that getting the two tracks into sync was extremely difficult.

Unfortunately the Pathe invention was unable to make any major

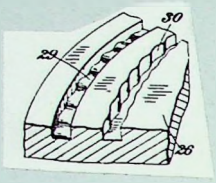


Figure 24: The Pathe stereo groove system, exhibiting a lateral and a vertical groove.

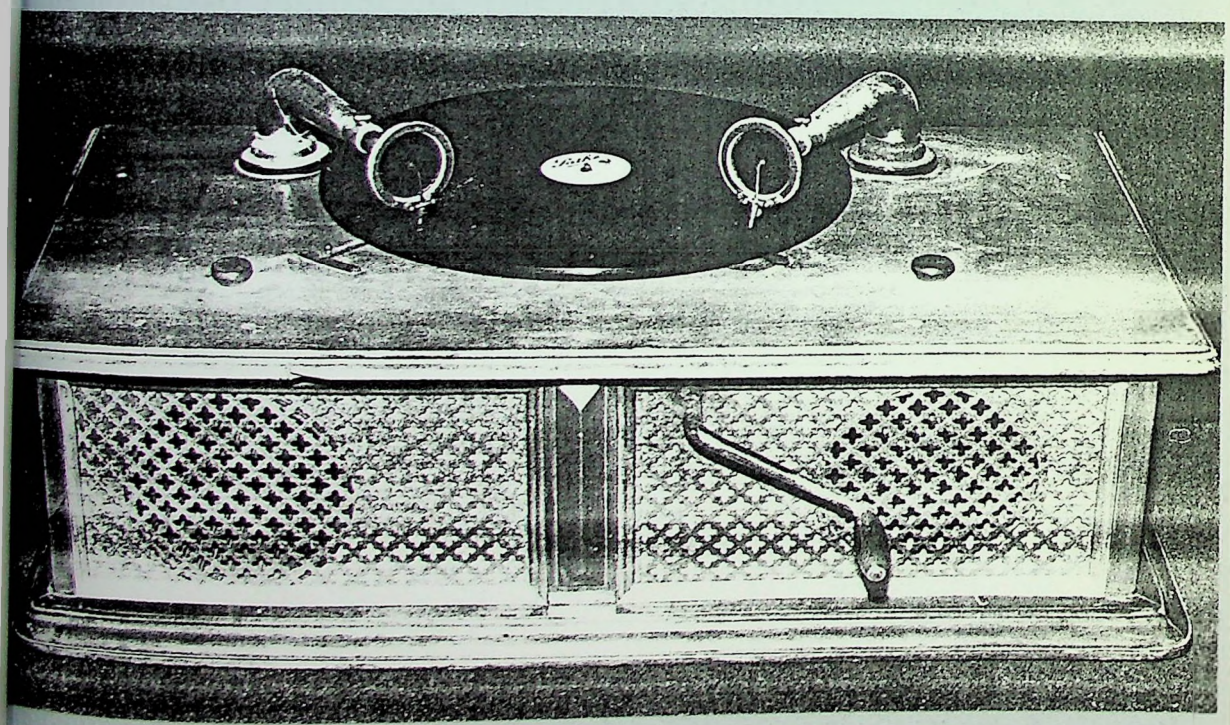


Figure 25: The first Pathe stereo player. Note the two tone arms.

impact due to World War I, and the stereo phenomenon disappeared during the war and was not subjected to further development until 1931, when Alan D. Blumlein, an employee of the Gramophone Company in England took out the first patent, covering stereophonic sound recording. Blumlein's patent covered two possible methods of carrying two sound channels on one groove. The first one was the VL or "vertical lateral" method. This was a combination of Edison's vertical hill and dale system, by which the signal was conveyed by a stylus moving up and down, and Berliner's lateral system where the stylus transmitted a signal by moving from side to side. This particular system had quite an amount of potential, and was quite feasible, but was considered inferior to the second atorage system i.e. the 45 / 45 Westerex system (see Figure 26). This was similar to the former except that the whole groove was tilted at a 45^{o} angle to the surface of the disc. It was in fact this system that was finaly adopted as standard by the record industry in 1958.

In 1948 a third stereo disc method was patented in England by W.H. Livy, in which a supersonic "carrier" frequency was modulated by two discrete frequency bands. Here what happened in simple terms was that the sound was carried on one groove, at a frequency created by adding the left and right frequencies together. To reproduce the sound then, the carrier frequency was split back into its components electronically, and the two channels became separated again. English Decca perfected this system in the early 1950s, but for some reason never followed it up.

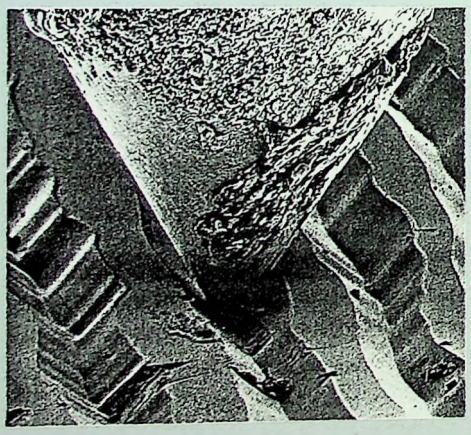


Figure 26: Groove and stylus detail of the Westerex 45 / 45 system. Note the dust buildup on the stylus.

Even though stereo discs were first developed in 1910 they were not marketed commercially until 1957, and in fact the very first examples which were made by "Emory Cook" were based on the Pathe double track system described earlier. To play these discs two pickup heads were ganged together, on one tone arm, and one track was stored on the inside half of teh disc, the other on the outside. This was closely followed by the first demonstration of the "Westerex 45 / 45" stereo disc, and Decca's demonstration of both their VL and "Livy's Carrier" systems. By the end of 1957, Decca became very frustrated having developed two separate systems out of four possibles, and subsequently put extreme pressure on the RIAA "The Recording Industry Association of America", and forced it to decide on a standard format for world wide adoption. The RIAA under such pressure recommended the Westerex 45 / 45 system, and within two months of their decision in summer 1958, the first 45 / 45 stereo discs were marketed by Audio Fidelity in the U.S.A., closely followed by Pye in the U.K.

One might question why it took so long for stereo discs to reach the marketplace. The reasons however were quite simple. Initially the whole development process was hindered quite seriously by the two World Wars, and secondly and most importantly, a suitable pressing material capable of carrying the high definition required by the complex stereo groove formulation was not available until 1957. The material which solved the whole problem was vinyl, which had vastly superior qualities to materials previously used i.e. "Vulcanite", "Celluloid" and "Shellac".

So it appeared that by 1958 the recording companies had solved their greatest problems. However solving the stereo riddle only created two completely new headaches for the industry.The first was the advent of fake stereo, which first appeared in 1959. The German composer Hermann "Scherchen" was greatly interested in advanced and experimental recording techniques, and had recorded a vast amount of material using the monophonic system. As a result, he wanted his music to retain its popularity, and subsequently invented and marketed what he called a "Stereophoner" which gave fake stereo from mono recordings, by splitting the frequenceis into layers, and feeding them separately to either channel. This device was intended solely for domestic use and sold for £ 5 in the U.K. By doing so Scherchen offered the customer a method of reproducing "stereo" like sound, from his or her "mono" collection, without having to invest in a stereo amplifier, thus providing major competition for the companies marketing stereo music. The second major problem recording companies faced was due to the fact that most record enthusiasts had mono systems, which were at that time incapable of playing 33 rpm 45 / 45 stereo discs. As a result stereo and mono existed side by side, which meant that record companies had to press two different versions of each and every recording. This also made life very difficult for wholesalers and dealers, because they had to carry double stocks of everything. This spurred manufacturers to look more carefully at stylus and catridge design, and as a result, by 1965 cheap cartridges with vertical as well as lateral compliance, capable of playing stereo and mono discs were developed. This was a giant step forward. Now for the first time, for a mdoest outlay, enthusiasts could start

buying stereo records in anticipation of the time when they wished to convert completely to stereo. The need for mono pressings therefore evaporated and it was time for mono to be phased out.

"Monocide" commenced in earnest on April 13th 1967 when EMI announced that as and from July 1968, all their classical recordings were to be issued in stereo only. Decca followed suit in 1969, and by 1975 the long and honorable mono reign was finally over. Fake stereo had also been discredited by this stage.

At last the stage was set for the great Hi-Fi race. Now that stereo was the norm, 1974 saw the beginning of the chase for perfection and in fact in the last 18 years some impressive results have been achieved. One area where large scale development has taken place in is cartridge and stylus design. At the moment one cannot buy better than an Ortofon moving coil cartridge. It is interesting to note here that not only does the example chosen (Figure 27) possess superb engineering qualities, but it also looks quite impressive to the untrained eye. Of course not every Hi-Fi is worthy of one of these items, which are extremely expensive. Ortofon have also put a massive amount of energy into disc cutting technology, and in fact their disc cutting heads are now the most widely used in the recording business (see Figure 28).

On the other hand, other companies have put vast sums of money into the development of turntables and pickup arms. The English company SME, have a reputation for producing superb tone

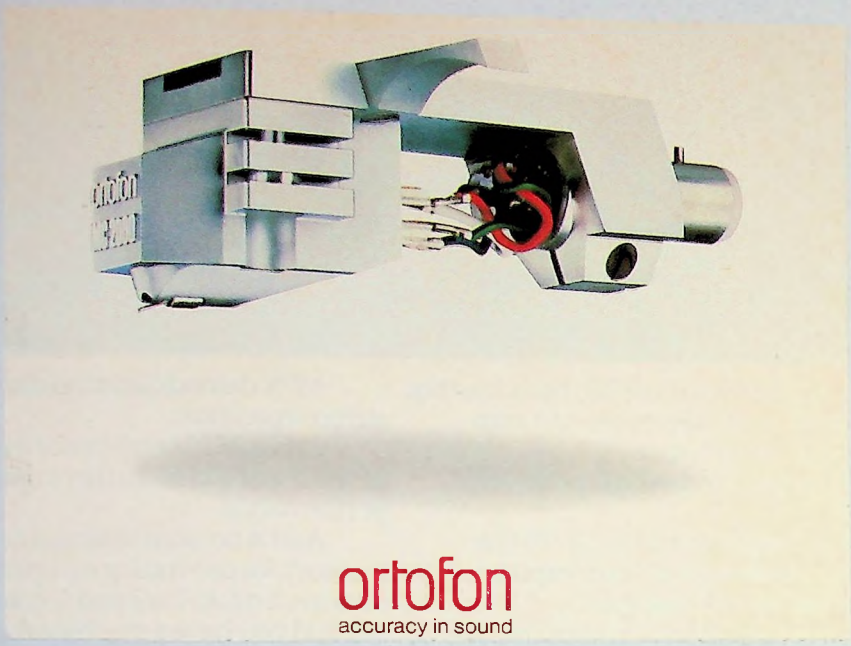


Figure 27: Ortofon moving coil cartridge from 1983.

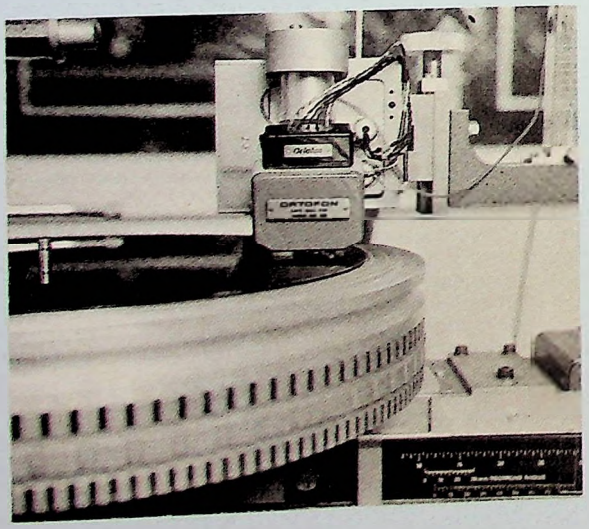


Figure 28: Ortofon disc cutting system from 1983.

arms, like the example in Figure 29. This particular design is purely functional in nature. It possesses a fluid damping system and a highly complex counter balancing system, to lessen the wearing effect of the stylus when placed in contact with a disc. The curved arm itself looks like a styling feature, but in fact is not. Its function is to lessen the wear effect of the tangentally moving stylus. The shape of this arm is endeavouring to solve the same problem tackled by the "Revox B 795 Direct Drive Turntable". In this example (Figure 30), the stylus is moved in over the disc radially, thus reducing greatly the prospect of the centrifugal force acting on it, wearing the disc.

Since the late 1940s record player turntables were all based on one design philosophy, up until 1980. This was the mass isolation principle, by which turntables were suspended on a shock absorber system to prevent scratches and holes being created on record surfaces. However in 1980 Janohurst Ltd. introduced a turntable relying on a totally different principle, which was mass damping. Here the turntable was mounted on a solid Welsh slate slab, and was itself segmented into eight separate discs, each with its own damping mechanism. This design (Figure 31) reduced vibrational feedback to the cartridge, and in fact won a prestigeous design award in 1980 for its innovational qualities. However it was never a huge market success because of its exclusivity, costing a staggering £ 3000. Nevertheless it was a giant leap forward aesthetically, and hence had its styling features copied on numerous occasions over the last eight years. The very latest in turntable technology can be seen in Figure 32. This is a

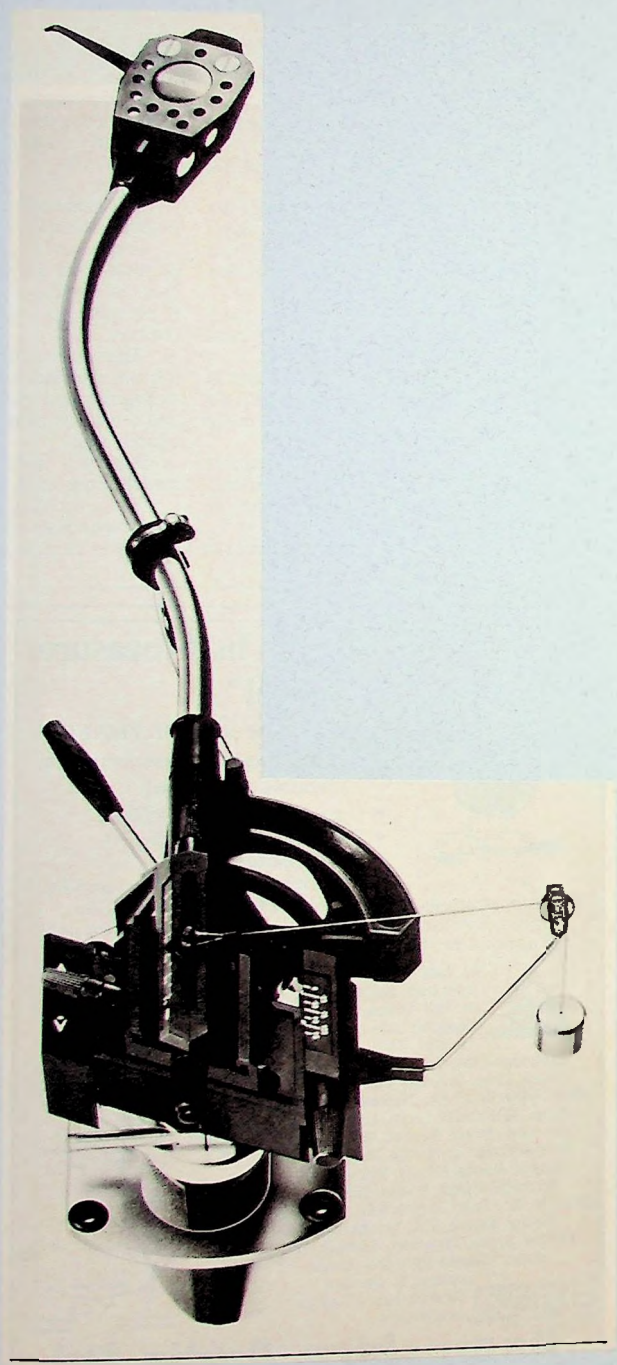


Figure 29: SME Tone Arm from 1983.

Figure 30: Revox B795 Direct Drive Turntable, from 1983.

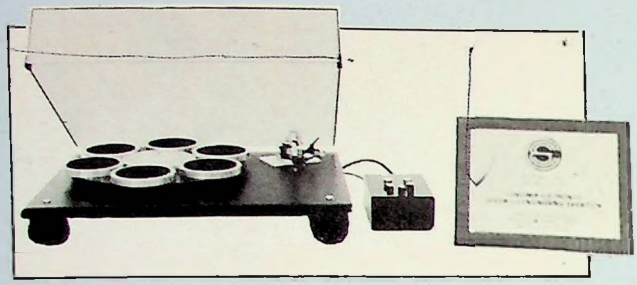


Figure 31: Janohurst's "mass damping" turntable from 1983.

Figure 32: The Cyrogeck constant level turntable

constant level turntable or "Gyrodeck" as it is called, but again costs a lot of money. This machine keeps the disc at a constant level relative to its stylus and reduces vibrational feedback just like the previous example. Its style is to say the least, striking, and is obviously aimed toward the rich, visually literate enthusiast.

Despite all of these marvellous innovations, the saddening fact is that stereo vinyl discs are still susceptible to scratching and wear, and as a result of this age old problem, the industry started looking for alternatives in the late 1960s. The results of this search are documented in the following chapter.

Chapter VI The Search for a Better Quality Sound

If stereo could be a wideranging success, the recording companies reasoned that four channels would provide an even more interesting and stimulating sound quality, and so the quadrophonic sound principle was born in the late 1960s. To take advantage of quadrophonic sound however, enthusiasts would have had to buy a special four channel quad amp, as well as an extra pair of speakers. By 1972, two different quad systems were available on the market; the CBS SQ system and the Sansui QS system, which were totally incompatible, so a "would be" enthusiast would need a separate reproducing system for each. As a result the market did not respond initially, and waited to see which way the quad cat would jump. Since it did not jump decisively in either direction, interest in the new wonder evaporated rapidly. In addition, the cost of QS and SQ systems was very high, and the reported ideal speaker position conflicted with the layout of most rooms, which have a door in one corner. So when the interest in Quad disappeared so quickly the music industry tried to find a new alternative method of improving sound quality. The answer lay in digital recording.

The principle behind digital recording is that the old system of recording sound onto tape, is replaced by converting the sound into binary digits via a computer, and storing this on tape. Theoretically no degradation of the original sound is possible, but in reality the digitized sound has then to be converted back into an analogue signal on the standard LP disc, and played normally. This allows for the sound to be

distorted again by warping of the vinyl disc used, and the old common problems of dust, static, and scratching.

The first digital recording ever made, was "Saturday Night Fever" by the B Gees in New York in 1977, but as mentioned, this was marketed on vinyl disc which lost its digital advantage with time. To get around these problems manufacturers started to look at the past for inspiration, and were influenced by a number of old abandoned designs, One such design was British Ozaphone's 4 mm film system, which had two sound tracks on it. This was the first sound system to use a light beam pick up, but unfortunately it is not known exactly how this system worked or how it differed from the movie / talkie film system. Another influential system was the light beam pickup "Philco model 41-629" photo electric reproducer of 1946. This system used a focused light beam in conjunction with a mirror system to read the record groove. However the no wear potential of this idea was negated by the need of a stylus to track the groove, in order to position the pickup. The RCA Victrola "Magic Brain" of about the same time apparently did away with this drawback, and in addition was advertised as being capable of playing both sides of an LP without turning it. For this purpose it used a double pickup and a "Jewel Lite Scanner". No further details are available on this particular design and apparently it never actually reached the marketplace.

The manufacturers then tried to tie some of these old abandoned ideas together with contemporary audio-video disc technology, especially the Telefunken AEG plastic foil discs

of 1970. These were single sided flexible plastic foil discs, of either 9 or 12 inch diameter, giving playing times of 5 and 12 minutes respectively. They had a vertically cut groove twenty five times finer than that of a stereo LP and were tarcked by a diamond stylus, carried by a tangental arm. The discs in question revolved on an air cushion at 1500 rpm, and were capable of reproducing black and white pictures with sound, which could be played back on standard black and white TV sets. A color TV system was developed in 1975, and Telefunken then hoped to put their technology into 33 rpm stereo discs, but alas lost the race to a much better system developed by Philips / Sony in late 1975. This was their laser read TV disc system, which had combined Telefunken's technology with a system resembling the RCA "Magic Brain" of 1946. It tracked a disc revolving at 1800 rpm on an air cushion with a laser feedback system. This design was the direct ancestor to what we now know as the compact disc.

The first announcement of the compact disc came on May 17 1978 from Philips Industries. Here Philips boasted a 4 1/2 inch disc with a one hour playing time (single sided). The disc had a 1.5 metres per second constant liner speed, and was read from the centre out. Here Philips used an idea produced by Pathe in 1926, i.e. a centre start disc which increased its speed as the pickup moved toward its outer circumference. In fact it is fair to say that the development of the compact disc was the final tying together of fifty years of development in sound reproduction technology.

The new technology used in compact discs and disc players,

is however quite a new departurem and is based on a very interesting set of principles. The information stored on the discs is encoded in the form of tiny pits on a spiral track (see Figure 33). The frequency of the pits and their depth, change the quality of reflected light from a laser diode, and hence sned back a digital signal to the disc player's processing computer (see Figure 34). The computer in turn decodes the digital signal back into a "clean" analogue signal, and passes it on to an amplifier, which in turn outputs the sound through a set of speakers.

This system has a number of great advantages: the sound quality is much "cleaner" because the computer between the disc and the amp only interpretes digital signals. Furthermore, because the tracks on a CD are so narrow and revolve at a constant linear speed, one hour of recording can be put onto a 4 1/2 inch disc. The discs (which are by the way read from their underside) are also much more durable than their vinyl rivals, and are not damaged by static loading or dust. Because of the multiple sampling operation of a CD player, a spec of dust will not effect the quality of sound output, due to the fact that the computer used is capable of correcting a tracking fault of 2.5 mm. This also means that if there is a tiny manufacturing flaw in a disc, the computer in the disc player is capable of compensating for it.

When we look at the production of the discs themselves, there is one fact of great historical interest. Compact discs are produced from photo etchings. The point of interest here being that Berliner's early discs involved almost identical

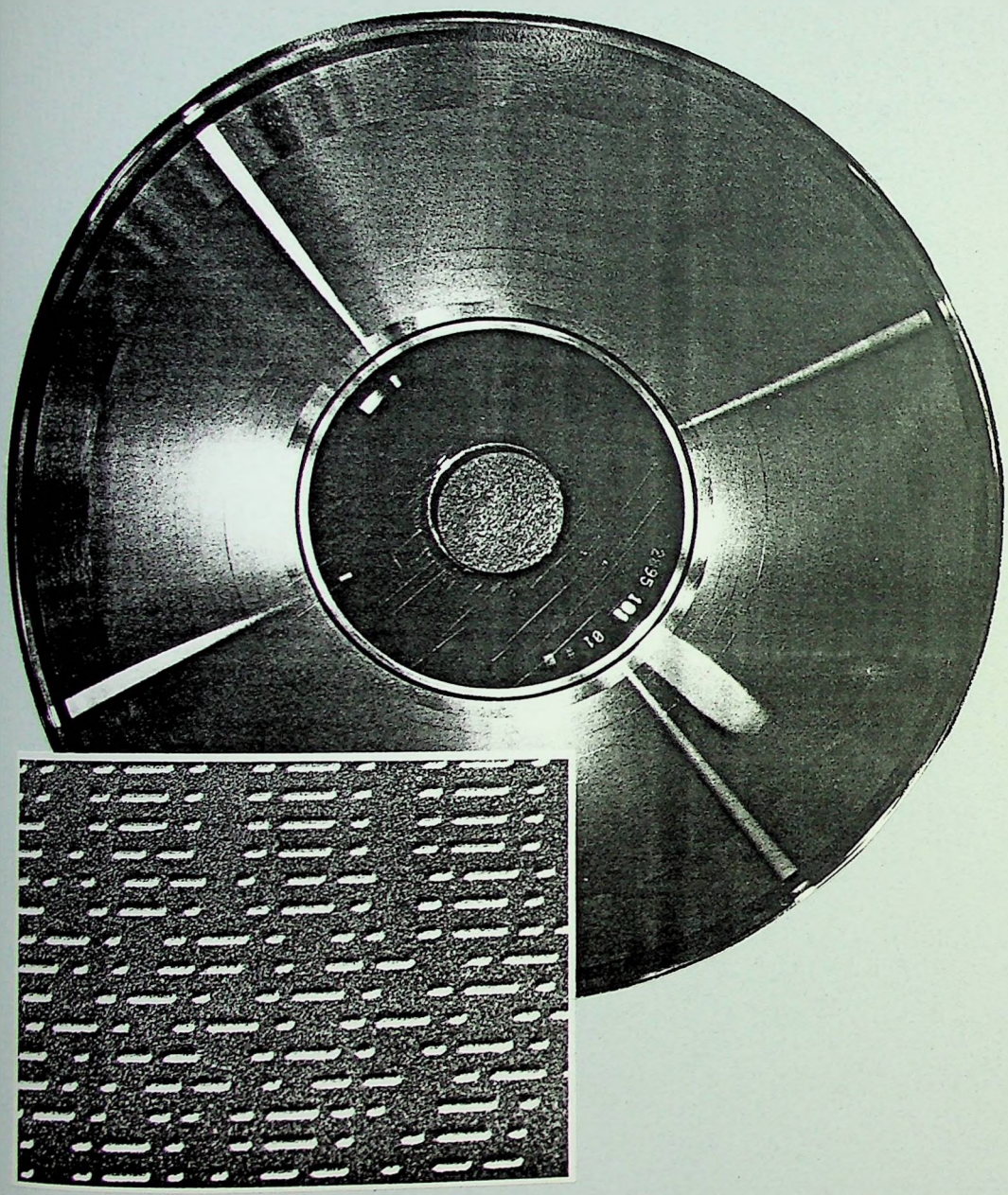


Figure 33: Detail of the surface of a compact disc.

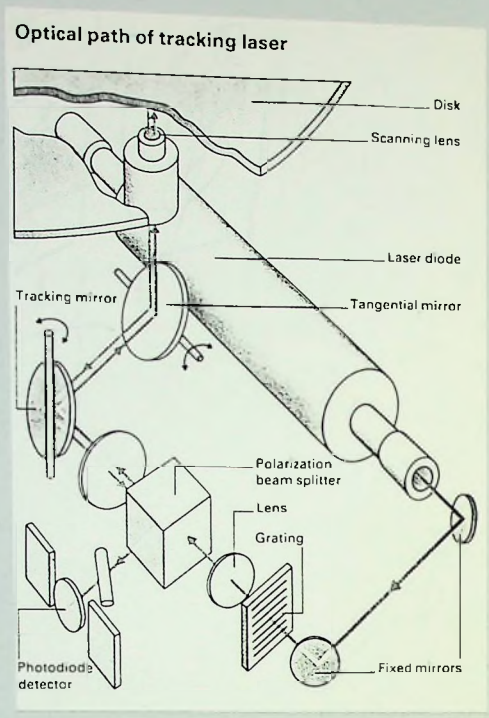


Figure 34: Playback system on a CD player. Note the position of the laser beam in relation to the pits.

Figure 35: Sony's CDP 101 compact disc player of 1982.

production methods, but in his case due to the lack of technology in this area, and the fact that the process was not suitable for coarse groove discs, photoengraving was abandoned for nearly eighty years.

Since 1978 not much has happened in compact disc development except for the fact that they became cheaper to buy, as we shall now see. The first CD players were introduced in Japan in October 1982. Sony's CD 101 was one of the very first and, as can be seen in Figure 35, was very box like in appearance. This model was fully remote controllable and was compatible with nearly all audio amplifiers on the market. Now on examining the 1988 NAD 5240 (Figure 36), we see a machine which looks almost exactly the same, except for the fact that it is slightly more conservative in appearance. The only difference between these two players is the moderately superior correction system of the latter. In fact the NAD 5240's sister player, the 5220 (Figure 37) is exactly the same in specification as the Sony CDP 101. The JVC and Philips 1987 / 88 collections show no unique developments either. However the new Hitachi range contains a new more stylish system. This is the slimline Opus Compo system, which is designed to sell as a separate Hi-Fi system. Here Hitachi have given a new identity to the compact disc player, and allow it to dominate as a visual form rather than just being another black box. (See Figure 38). At the moment Sony and Philips are endeavouring to bring CD players into two more established markets. One is the portable stereo i.e. Ghettoblaster market, (see Figure 39). Introducing compact disc players into this market seems a rather dubious decision, because the two in one "tape" system

Figure 36: 1988 NAD 5240.

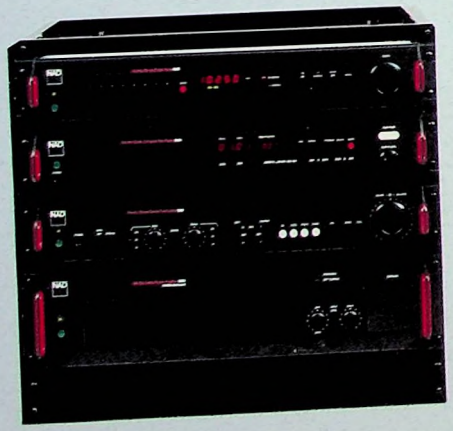


Figure 37: 1988 NAD 5220.

Figure 38: 1988 Hitachi "Opus" campo system.

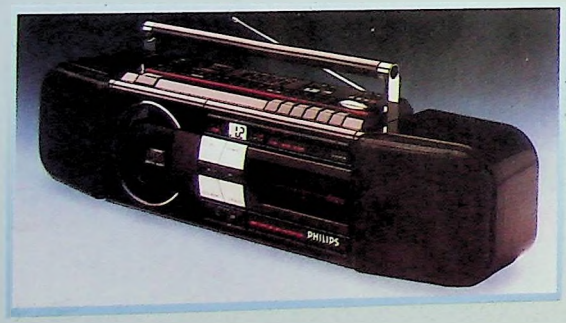


Figure 39: Philips D 8484 "Compact disc sound machine" 1988.

has become a traditional "buy" for lower income people, both here and in the U.S.A. The fact that cassette tapes are so much cheaper than compact discs also means that these systems are going to find the market very tough indeed. The other market being explored is the personal stereo or "Walkman" market. Here the compact disc player has a much better chance of success, because the Walkman has become somewhat of a status symbol among the so called "Yuppie" class. (See Figure 40). In this area great scope is available to create a new styling image for the compact disc player, and in fact Sony are already involved in producing players which exhibit a higher degree of visual appeal than the traditional "square box" format. One such example can be seen in Figure 41. This example has a highly organic appearance and in fact succeeds in creating a new image for the compact disc player.

Compact disc players are only capable of playback, and consequently do not allow the owner to record and re-record as he wishes. This particular fact however may be an Achilles heel if the compact disc is going to lose its prominence, because just around the corner is a new system capable of producing an equal sound quality, at a lesser cost. This system is D.A.T. or digital audio tape, and would allow the customer to record digital sound at a fraction of the cost of buying compact discs. This system is not available in Ireland, the U.K. or the U.S.A. yet, so the CD player is still safe here. However it is on sale in Germany and Japan, enjoying remarkable success. At last after nearly eighty years of domination the disc has a clearcut rival.

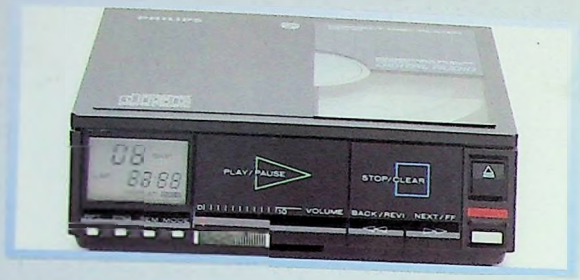


Figure 40: Philips Compact disc "portable CD 10".

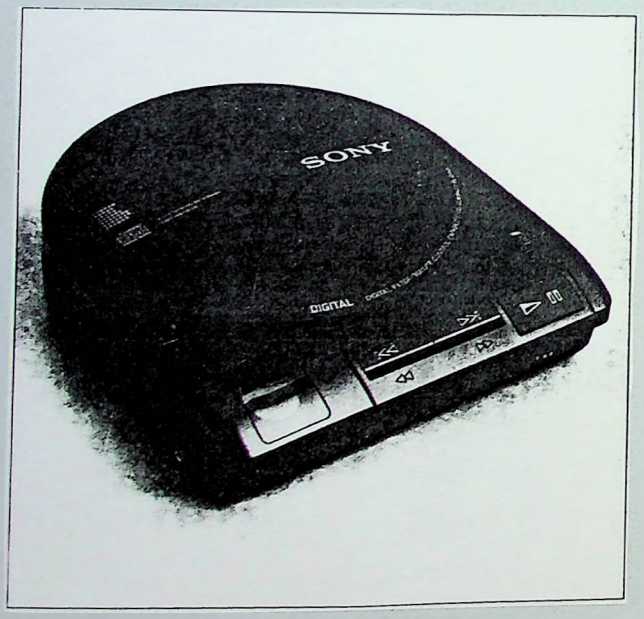


Figure 41: Sony Discman D 600 portable compact disc player.

Conclusion

On examining the developments in sound recording technology over the past century, we saw how various factors accelerated and retarded progress during various eras. For instance, Thomas Edison's contribution before the turn of the century was colossal. However in the earlier part of this century he refused to get involved in the development of gramophone technology. At this stage, it seems as if his business interests obstructed his innovative genius, and had he collaborated with "Bell Telephone" and Berliner, gramophone technology might have taken a totally different direction. One thing is certain though, if he had done so, development would have been much quicker.

The most fascinating fact concerning Berliner and Edison is the way in which the electrical recording principle totally eluded them, even though both had considerable experience in contemporary telephone technology. The irony here being in the fact that electrical recording developed as a result of sheer necessity rather than inspiration.

The most important development in subsequent years was due to the second World War. Decca's "submarine engine" recording system was a giant step forward and laid the foundation for development in stereo recording. As a result, when vinyl first appeared on the market in 1957, the recording industry was equipped to use it to full advantage. Had these events not happened, the rock / pop revolution of the 1960s may never have happened either.

By 1971 stereo recording had undergone a considerable amount of development and was reaching a saturation point, so the industry tried to develop still further by developing quadrophonic sound. Had either the SQ or QS quad systems been adopted as standard for future developments, it is almost certain that the next era in development i.e. digital recording, would have taken a rather different path. If this had happened our modern day compact disc would not exist in its present format.

Sound recording and reproduction is now over a century in progress and has been dominated throughout by cylinder and disc storage systems. However at the moment the most modern disc system i.e. compact disc, is under increasing pressure from the latest technological marvel, digital audio tape. Unfortunately it appears as if this system is poised to take over the market shortly and will finally put an end to the long and honorable reign of the disc.

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Bibliography

1. GELATT, Roland, The Fabulous Phonograph, 1877 - 1977 (2nd edition), Cassell, London 1977.

2. MOSELEY, Sydney, A, and BAITON, Chapple H.J., Television To-day and Tomorrow. Sir Isaac Pitman and Sons Ltd., London, 1930.

3. MARTY, Daniel, An Illustrated History of Phonographs and Gramophones, Edita S.A., Lausanne, 1979.

4. CHEW, V.K., Talking Machines, Her Majesty's Stationery Office, 1967.

5. GAISBERG, Fred, Music on Record, Robert Hale, 1947.

6. MEADOWCROFT, William H., Edison, Payot, 1929.

7. READ, Oliver and WELCH, Walter L., From Tin Foil to Stereo, Howard W. Sams and Co., 2nd edition, 1976.

8. LOWE, Jacques, The Incredible Music Machine, Quartet, London, 1982.

Periodicals

9. Hi-Fi Choice, January 1988

10. Hi-Fi Today, November 1983

11. Hi-Fi Today, September 1980

12. Design Magazine, February 1988

13. Promotional brochures 1987 / 1988
JVC, Philips, Hitachi, NAD and Sony.