Wandering in Magnetic Fields

December 1st marks the centenary of the invention of magnetic recording. **Bernard Pike** and **Ken Talbot** trace its history and the fortunes of its Danish inventor, Valdemar Poulsen

LOOKING BACK over 100 years of magnetic recording offers an interesting study of how an invention develops. The years to the death of inventor Valdemar Poulsen in 1942 saw limited progress. From his wire-based Telegraphone, the Blattnerphone and the Marconi Stille steel tape recorders do not fit in well with the development pattern of magnetic recorders. The key events took place in the thirties and forties and were followed by exponential growth up to the present day. It was after the war that magnetic recording started to make itself felt in the recording studio, and displaced the shellac disk as the standard medium. Today magnetic tape is threatened on two fronts by optical and solid-state technologies. What does the future hold for magnetic storage?

Poulsen was working for the Copenhagen Telephone Company when he first started experimenting with recording. The first recording is reputed to have been made on a screwdriver, using a telephone earphone without the diaphragm as the record and playback head. Once the basic principle was established, he went on to record on a piano wire stretched across his laboratory. He operated it by running alongside the recording apparatus, which was perched on a trolley, with the record head (earphone) in contact with the wire. The final patented version had the wire coiled around a drum with the head driven by a screw thread at the top of the machine.

In 1900 at the Exposition Universelle in Paris, he exhibited his invention. It was well received and he was awarded the Grand Prix of Paris. One of his visitors was the Austrian Emperor who made a recording at the exposition that is believed to be the earliest magnetic recording still in existence today.

As Poulsen was unable to find backers in Europe, in 1903 he formed the American Telegraphone Company with an American associate in Washington DC. The duo started to produce wire recorders where the wire ran from one spool to another. The first machines had a wire speed of 84ips and could record for 30 minutes. By 1910 the company was in trouble due to bad management and by 1918, after only selling a few hundred machines, it went into receivership. Amazingly it remained in existence until 1944; although whether Poulsen was still involved is not clear and not much more seems to be known about Poulsen until his death. He did, however, receive many awards.

In 1907, Poulsen was awarded the Gold Medal of the Royal Danish Society for Science. In 1909, the University of Leipzig conferred upon him the honourary degree, Doctor of Philosophy. He received from the Danish Government the Medal of Merit and at his death, Dr Poulsen was a fellow of the Danish Academy of Technical Science and the Swedish Institute for Engineering Research.

There are a number of reasons why Poulsen's invention did not immediately succeed commercially—the Edison Phonograph had been invented 20 years before Poulsen's Telegraphone and had already gained a foothold in the market. And where the Telegraphone needed to be listened to on a headphone, the Phonograph used an acoustic horn. If amplifiers, had been around Poulsen would have had a better chance. An additional handicap derives from the fact that AC bias had not been invented, so the Telegraphone's signal was distorted and had >

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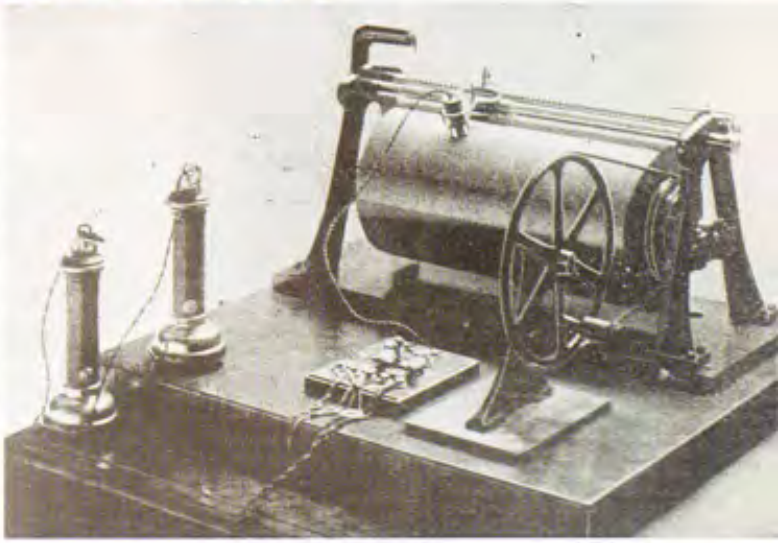
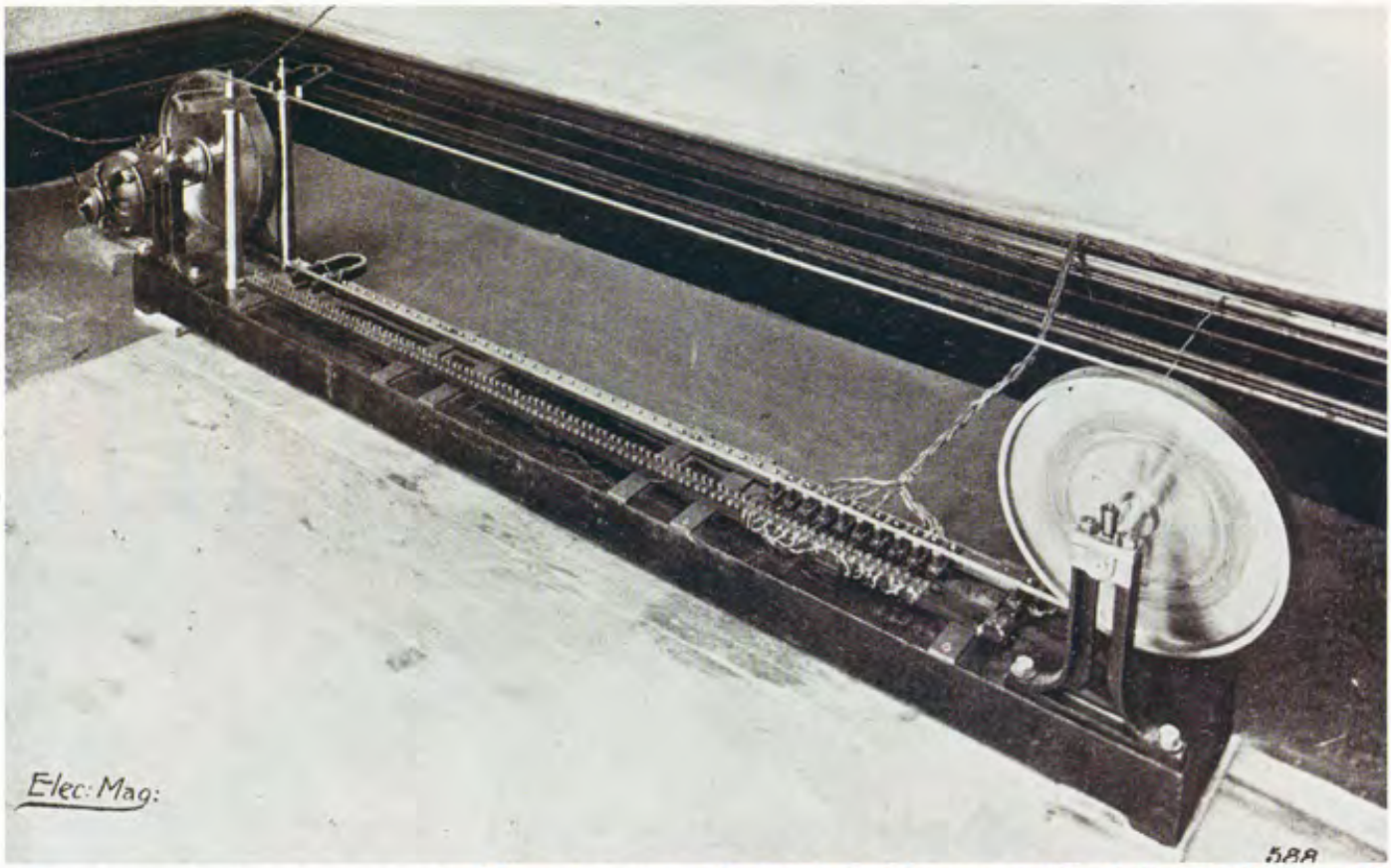


Illustration of Poulsen's Telegraphone published in *The Electrician*, 1901



Telegraphone arranged for distributing information, published in *Electrical Magazine*, 1904

< a low output. Further, the wire itself often became twisted and tangled. Finally, Poulsen was also busy with his other invention, the Continuous Radio Wave Arc Transmitter, which dates from 1902. This must have diverted his attention away from running his company.

Despite Poulsen's lack of success with these machines, other companies had moderate success with wire recorders, and they were manufactured right up to the late forties. One of the more famous and more successful machines was the Webcor wire recorder whose head rose and fell as the wire passed. The head had a groove in it so it also acted as a guide that made sure the wire was evenly wound onto the take up-spool; although here, too, the wire often broke and acquired kinks that caused severe dropouts. It also caught under other layers of wire and would release with a jerk.

Among the other wire recorders that were made, were the Brush which was developed by SJ Begun (the Brush Development Company also developed a number of recorders which used a variety of tapes, disks and wires); the Stille wire recorder from Curt Stille and Karl Bauer, which was called the Dailygraph and was manufactured by the Vox company as a telephone answering or dictation machine; and the Textophon developed by the Echophon company, which was used as a dictation machine. Several thousand wire recorders were sold to the American Army and Navy, many being built or licensed by the Armour Research Foundation of the Armour Institute of Technology. In 1949, there were still wire recorders being built and one of these, the Wirex Recorder has a home in the Science Museum in London.

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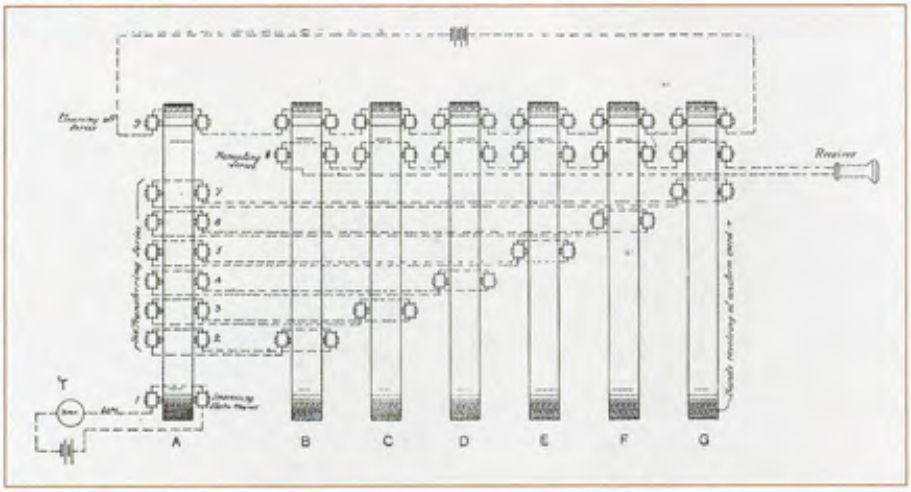
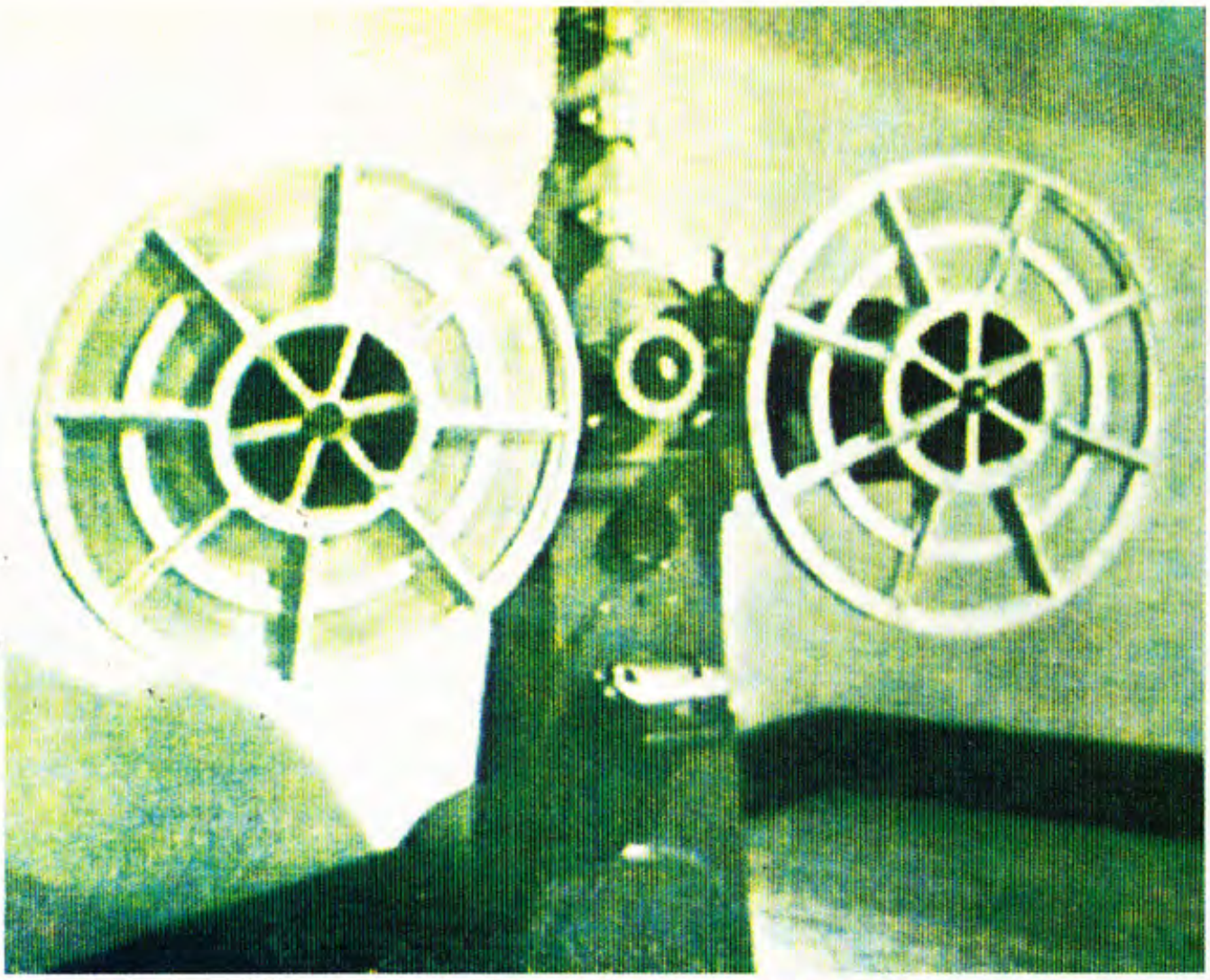
Apart from as dictation machines, telephone answering machines and home recorders, wire recorders had little use and there appears to be no reference to them being used in the recording studio. Their success was very limited when compared to the commercial success of the tape recorder.

Steel tape machines made their appearance from time to time, only to vanish again as quickly as they came. There are two machines, which stand apart—The Marconi Stille machine and the Blattnerphone. These machines had a short but interesting appearance in the professional broadcast section of the market. The Blattnerphone sounds like something out of comic opera, but there really was a recorder by this name. Blattner, the designer, sold machines to the BBC and went bankrupt in the same year. The machine was a rather unwieldy giant with enormous reels to hold the steel tape. The story goes that it was necessary to keep the machine in a room of its own as when the steel >

Illustration for a proposed telephone repeater using Poulsen's Telegraphone, published in *The Electrician*, 1901





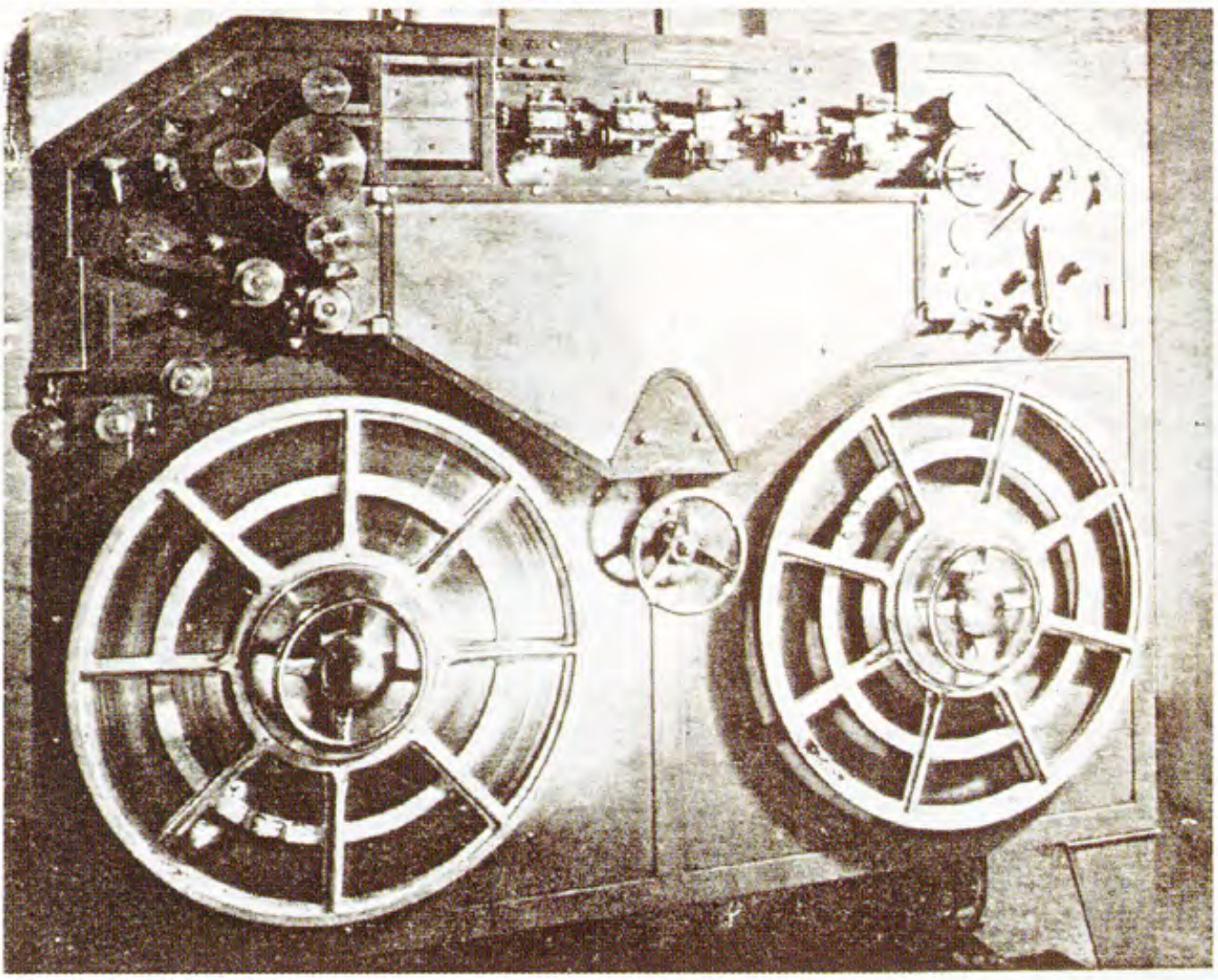
One of the successors to the Telegraphone was the Blattnerphone seen here. It was used by the BBC at an operator's peril.

< tape snapped the loose ends would whip around with dangerous effects. Dr Bates, of Verbatim, tells the story, that one day during a live recorded broadcast from the Blattnerphone, the steel tape broke. Being the junior engineer at the time, he was required to grab the broken end of tape and run down the corridor with the tape trailing behind him to keep the tape from becoming snarled. He said he was the first person to break the tape and then run 100m... The famous speech made by British prime minister Neville Chamberlain's when he declared war on Germany, was recorded on a Blattnerphone.

Later, steel tape was used on the Marconi Stille machine and these machines were used extensively in the years leading up to the Second World War. Steel tape had the advantage that it did not twist, but it was no rival for the German Magnetophon. This machine together with tape would change the course of recording.

It was Fritz Pfleumer who made the breakthrough that would change the direction of magnetic recording and move it in the recording studio, when he patented a coated paper-backed tape. Pfleumer was working on a metalised cigarette end for a cigarette company; >

Another pretender to the Telegraphone's crown was the Marconi-Stille steel tape recording machine



Clockwork disc-type Telegraphone for early recording and replay —as a Dictaphone, for example

his hobby however was recording, and one day when his wire recorder's wire became all tangled up, he hit on the idea of using a metalised tape. In 1928 he patented the idea and sold it to AEG, a large German manufacturer, in 1932. While AEG made the recording hardware, it needed a chemical company to make the tape—the job fell to IG Faben. At first the tape was coated with pure iron particles as Pfleumer had originally conceived. This was not very successful as the fine crystal shapes became unstable and oxidise. Strangely, iron oxide (rust) is not magnetic, but IG Faben with its knowledge of chemistry was able to develop a propriety process which resulted in a carbonyl iron powder that was magnetic, stable, and you could produce fine needle-shaped (acicula) particles to coat the tape.

In 1934, 36 years after its invention, magnetic recording became a serious competitor to its arch rival, the disk. Until this time, disk had been the main storage medium in the sound studio but it could not be edited—all recordings were instantaneous, and after the engineer had dropped the cutter head onto the disk and spiralled it in, the band had to play, and play without making a mistake. The count-in had to be silent as well. Paper, or plastic-backed tape could be cut up, the best parts of the recording selected and edited precisely to produce a faultless performance. Editing had arrived.

By 1939, 5,000,000 meters of magnetic tape were being produced for broadcast stations. In the UK, EMI and the BBC were dominant forces in recording and it appears from our research that magnetic tape was virtually unknown here.

It was Hitler who was to aid recording over the war years. Hitler supported magnetic recording as it was useful in his propaganda campaign. British intelligence used to monitor Hitler's broadcasts in order to know where he was. Not knowing about the developments of magnetic recording inside Germany, they would listen for the familiar clicks or surface noise of the gramophone record. If there were no clicks it was assumed that Hitler would be present. It soon became apparent that this could not be the case as Hitler would make addresses at two distant places within too short a period for him to travel the distance.

Once the war was over, American GIs captured a number of the Magnetophon machines and shipped them to America where they were taken apart and analysed. The British brought them back and EMI developed the famous BTR1 machine, which was based on the Magnetophon design and by 1945, Bing Crosby, working with sound engineer

John Mullin, used the Magnetophon for radio broadcasts on ABC Radio.

The early tapes ran at 30ips and shed oxide with each pass. In America 3M developed Type 111, a plastic-based tape, that quickly became the industry standard. Slowly research on tape delivered an improved medium, and from coercivities of less than 100 Oersteads, it was possible to achieve coercivities of as much as 350 Oersteads by the late fifties.

It was during this period that tape machines quickly displaced disk recording in the studio, both in recording studios and broadcast studios. With improvements in head design, the very limited frequency response of the early machines was increased and by the sixties they were able to produce a flat frequency response from 20Hz–15kHz.

During the sixties tape speed was standardised to 15ips in the studio and with all the modern developments, hi-fi was born. In Germany the Telefunken machine was mainly used, in the UK it was the EMI BTR1 and BTR2 and TR90, and in America the Ampex model 200 was the studio workhorse. In Japan, after a devastating war, Sony was busy developing its own tapes and tape

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machines. To show the level of enterprise, TDK was producing tape which had the oxide painted on using a pig's hair brush, and the slitting was achieved by pulling the coated film over razor blades. It was in the sixties that the Japanese started to compete in the West with their high performance tapes.

The chemical giant Dupont, in America, had developed a new Chromium Dioxide particle. This increased the tape coercivity values to over 500 Oersteads and gave a flat frequency response all the way up to 20kHz at even lower tape speeds than were commonly being used. Consequently, many studios using the famous Revox machines were able to record at 7.5ips; although for editing 15ips was still preferred. Dupont issued a licence exclusively to Sony in Japan to produce chromium dioxide tape. Not to be outdone, TDK developed a cobalt-doped tape called Super Avilyn. New tape machines also appeared on the market, such as those from Studer and Nagra. These machines were in a class of their own with a frequency response of ±0.5dB over the full 20Hz–20kHz spectrum.

The use of tape became far more widespread over the coming years, being used for Video recording, Data and with the introduction in 1962-64 of the compact cassette, home recording.

With the advent of multitrack machines the whole process of recording changed—the ground-breaking *Sergeant Pepper's Lonely Hearts Club Band* was recorded on a Studer 4-track machine and later *Abbey Road* was recorded on one of the first 8-track machines. By 1970 multitrack recording had once more transformed the way recordings were being made. Now with far more options open to the producer, engineer, and musicians, recordings were taking years to be made. The disk could not compete.

Poulsen saw his invention mainly as a telephone answering machine. Using wire, it was only suitable for speech, as claimed in his original patent (dated 1.12.1898). Today, telephone answering machines are solid state with no moving parts, no tangled wire, no wow, no waiting to rewind the tape for the next take.

Tape was able to challenge the disk only once it was improved in quality, was suitable for editing and finally it was multitracking which cemented its superiority in the studio. We may have almost forgotten Poulsen today—ask the man in the street who Poulsen is and you can be sure to get a blank look—but his invention was a brilliant breakthrough and deserves recognition. Without his pioneering efforts, where would the modern recording industry be? ■