Neumann History

1928 - 1998
English

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Georg Neumann – An Inventor and His Life's Work

Company founder Georg Neumann was born on 13 October 1898, in Chorin, some 80 km Northeast of Berlin. He received his vocational training at the firm of Mix & Genest in Berlin. Later he worked in a research laboratory at AEG's Oberspree Cable Works where the focus was on building amplifiers. Eugen Reisz was director of this laboratory. A short while later, he founded his own firm and took on Georg Neumann as an employee.

In those days, the microphones commonly used for sound recordings were carbon microphones. These resembled a shoe polish tin, partially filled with carbon grains, with openings on one side to admit the sound. These openings were backed by fine gauze to prevent the carbon grains from falling out. By modern standards, the quality of these microphones was dreadful. The transducer principle used in these microphones was also jokingly referred to as a "controlled loose connection".

Georg Neumann examined this microphone, scattered powdered carbon on a marble slab, inserted two electrodes, introduced a direct current, and spoke into this configuration. A corresponding response which, by Georg Neumann's account, was very "thin", emanated from the attached loudspeaker.

Next Neumann stretched a rubber membrane over the contraption, spoke into it again, and suddenly the low frequencies were there. A new microphone was born, the Reisz marble block microphone.

It was into this microphone that the first German radio station, a Berlin station broadcasting on the 400 m band, sounded its "first yawp" from Vox House on Potsdamer Platz in 1923.

With a linear frequency response between 50 Hz and 1 kHz this microphone had an excess of 10 dB up to 4 kHz, which decreased to approximately 15 dB at 10 kHz. Not quite what we would call a studio microphone these days.

Neumann had never been one to settle for compromises. In and of itself, the microphone was indeed a sensation. Consumed by the idea of mass producing a microphone using the capacitative transducer principle, he soon parted company with Reisz to found his own firm in Berlin, together with Erich Rickmann, on 23 November 1928.

Since until then the only place in which it was possible to manufacture a condenser microphone was in the laboratory, his plans for industrial production seemed rather fantastic.

The Neumann Bottle

The CMV 3 was the first ever mass produced condenser microphone, far superior to the Reisz microphone, and it gained recognition under the nickname of the 'Neumann Bottle'. It wasn't exactly small, measuring approx. 9 cm in diameter and approx. 40 cm in height. Its weight of nearly 3 kg made reporting a very strenuous job.

Telefunken, a subsidiary of AEG and Siemens, took on the marketing rights to Neumann's microphone.

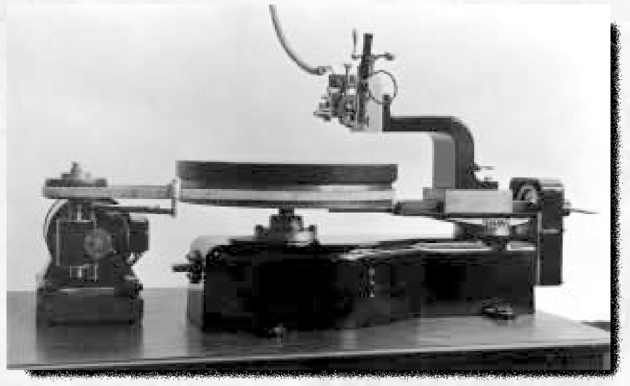
Between 1928 and the end of World War II the Bottle's design remained virtually unchanged, during which time it became firmly established as the standard for studio use and was used extensively in the 1936 Olympic Games in Berlin. At this time there existed already a selection of exchangeable capsule heads with different polar patterns.

More than Just Microphones ...

By 1928 Neumann had spread his attention to other aspects of studio engineering, such as record making. It was his interest in record technology that was, in fact, the real reason for the split with Eugen Reisz.

His enthusiasm and Reisz' opposition were stirred by a commission from Neumann's friends in England to build a machine for cutting records. This machine was to become the basis for Georg Neumann & Co's secondary line of products.

The earliest disc cutting machines were belt driven. The head was moved forward by a spindle, which was itself driven via a worm



gear and a further gear from the base of the turntable. The obvious parallel between this configuration and later record playing deck is particularly significant when it is considered that by 1930 Neumann had already made the transition from belt drive to direct drive with the motor acting as a direct extension of the turntable spindle.

Throughout the '30s and early '40s the company began to take on a recognisable shape. Diversification brought continued innovation, ranging from electro-acoustic measurement equipment to cinema gongs and station identification code signals (used by broadcasting companies to broadcast their station identification) to standard linear microphones.

Neumann also developed a pistonphone for calibrating both standard and pressure microphones. The pistonphone generated a sound pressure which could be controlled optically with great accuracy within the 20 Hz to 600 Hz range via the movement of a piston which displaces a given volume of air. The amplitude of the piston was observed through a microscope, enabling the microphones to be calibrated to an exceptionally high degree of accuracy.

His Most Important Invention?

It was during the course of this widening development work that Georg Neumann made his most important contribution to modern electrical engineering. In 1947 he developed a process by which nickel-cadmium batteries could be made without the excessive formation of gas and so totally gas tight – an invention that has direct links with virtually every modern electronic apparatus. Flash units, hearing aids, cameras, radios, etc, all rely on minute nickel-cadmium batteries, whose availability is the result of this development.

One of the by-products of Neumann's process were stability cells, containing a cathode consisting essentially of cadmium, cadmium oxide and a nickel anode. These cells had a comparative capacitance of 100 to 160,000 μF at a frequency of 50 Hz, depending on the size of the cell, and Neumann was able to use them to stabilise the heating voltage for condenser microphones.

Their outstanding filtering capacity was extremely useful for filtering the heating current, particularly for directly heated tubes.

The Big Success

In retrospect, 1947 was a prolific year for the Neumann company. On top of one major discovery the company launched the microphone that has probably had the greatest influence in the development of modern studio microphone technology. The U 47 was the first switchable pattern condenser microphone. Its impact, especially in America, was such that the dominance of RCA's ribbon microphone as the studio standard was eclipsed.

The U 47 had a double diaphragm capsule. Both diaphragms could be polarised with the same voltage or neutralised with respect to the centre electrode, so that the omnidirectional and cardioid characteristics were adjustable. A 'special' (U 48) was also produced, in which the diaphragms could be polarised with opposite voltages with respect to the centre electrode, so that it was possible to switch between cardioid and figure-of-eight directional characteristics.

The First Remote-Switchable Microphone

Other models appeared in 1949 and 1950, both bearing some notable progress. In 1950 the M 50 featured a pressure capsule embedded in acrylic glass to give an outstanding omnidirectional pattern. But more important was its predecessor, the M 49, which was the first microphone that could be remote-switched.

Neumann's work on the M 49 coincided with a similar invention by an engineer called Grosskopf, of the Central Laboratory of the Nordwestdeutscher Rundfunk in Hamburg. Here, one microphone diaphragm was fixed in the opposite direction to the centre electrode while the other one received a capsule bias which could be varied via a potentiometer.

This made it possible to switch the characteristic smoothly from omnidirectional, via cardioid, to figure of-eight.

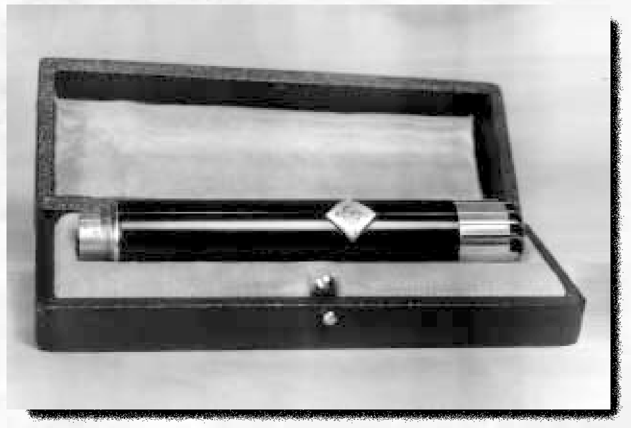
But it was Neumann, who somehow managed to acquire the patent for this, that went on to produce the first remote-switchable microphone, the M 49. Soon there were numerous versions being launched by his competitors, all of course made under license from Neumann.

New Demands Posed by Television and Sterephony

In Europe during the '50s the two most important developments in broadcasting technology were undoubtedly the upsurge of television and the arrival of stereophony, both requiring their own specialised microphones.

By 1953 Neumann was meeting the demands of television companies for smaller models with a selection of condenser microphones only 21 mm in diameter choice of omnidirectional or cardioid models were available, plus a switchable model which combined omnidirectional, cardioid and bi-directional characteristics.

To record in stereo naturally called for two microphones placed in such a manner that



their time/amplitude response was coincident. The ideal solution therefore was to mount two capsules in one housing.

In 1956 Neumann produced the SM 2, which was to remain the only stereo microphone in the world for many years.

Measuring Technology

During the course of the next two and a half decades the potential for realistic sound reproduction offered by stereophony generated intensified research in the recording world. For the laboratories one of the first breakthroughs was the arrival, in 1934, of Neumann's P 2, the first factory produced logarithmic-display lev-

el recorder. This became the standard measuring equipment in acoustic testing laboratories for many years, notching up world-wide sales in the process.

In this connection, one also should not overlook the calibration microphones developed by Neumann.

From Tubes to Transistors

The aforementioned miniature microphones of the fifties and sixties were, of course, all tube microphones. Considering the small diameter of these microphones, this continues to amaze many users even today. The tube used was usually the Telefunken AC 701 tube, which had been developed especially for use in microphones. For the time being, Neumann's last tube-driven microphone circuit, developed in 1960, was destined for use in the U 67 switchable large-membrane microphone. It also marked another milestone. This microphone model, which survives today as the U 87 A, can rightfully be called one of the world's most well-known studio microphones.

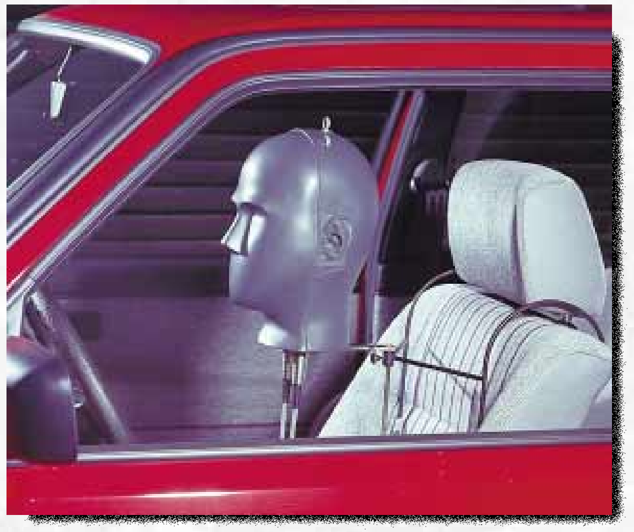
In the sixties, tubes used as amplifiers and impedance converters were increasingly replaced by transistors. Upon the market launch of the field effect transistor, at the latest, condenser microphone circuits proved to be no exception. In 1965, Neumann introduced the "KTM" 1965, his first microphone with transistor circuitry. A short time later, Neumann developed the concept of "phantom power" with 48V. Now it was no longer necessary to have a separate power supply for each microphone. Instead, all microphone inputs could be fed centrally with 48V. The special, multi-core microphone cable was dropped in favour of three-core standard cable, The numerous connector types were unified and have now been replaced world-wide by three-pin XLR connectors.

The variety of microphone models, however, increased: First the existing, well-tried models of the 60 Series (e.g., KM 63, 64, and 65, U 67) were replaced by successors using semiconductors. Starting in 1966, these were the small and large membrane microphones KM 83, 84, 85 and U 87 of the "fet 80" series for 48V phantom power.

The remote-switchable SM 69 fet microphone was joined by the locally switchable USM 69; the KMS 84 and KMS 85 microphones for vocalists were developed, as well as the KMR 81 and KMR 82 as representatives of a new microphone type, the shotgun microphone.

Artificial Ears Learn to Hear

At the 1973 International Radio and Television Exhibition in Berlin, the world witnessed the debut of the "Dummy Head". This marked



the invention of "binaural" stereo recording. Neumann developed the first KU 80 Dummy Head in close scientific cooperation with the Berlin-based "Heinrich-Hertz-Institut". It was designed for true-to-life recording of environmental acoustics. Later, these recordings could be played back to test persons via headphones in order to subject the recordings to an objective evaluation. It quickly became apparent, however, that this three-dimensional auditory experience also permitted very exciting radio productions, and the dummy head established itself as an additional stereo microphone alongside the "classic" models mentioned above for the so-called "coincidence method". Soon the improved KU 81 Dummy Head came on the market, followed by the third-generation KU 100 in 1992.

Semiconductors for Studio Mixing Consoles

While the developments at Neumann can be chiefly related to advances in its condenser microphone technology, the company remains very much involved in the manufacture of disc cutting equipment, as well as the more directly associated field of complete sound mixing systems.

In the initial years of semiconductor development, the world was flooded with tiny "six-transistor radios". Everybody had one, and they crackled and hissed music and information wherever one turned. In terms of quality, however, they were nothing to write home about. This had less to do with the semiconductors themselves than it did with the application of this interesting component back then.

Throughout the company's history, Neumann had continually pushed the limits of physical possibility with regard to studio engineering equipment. Why shouldn't one be able to manufacture a studio-quality amplifier using transistors, too? The development contract was awarded, and the first amplifier built was a 34 dB amplifier, designated "TV", which had excellent specifications. It was to become the heart of a series of studio devices and gave rise, for example, to the TEV equaliser and the TRV channel controller. The individual components were developed in the early sixties. Then at the 1963 Radio and Television Exposition in Berlin, Neumann debuted its first all solid-state mixing console. It had 10 input channels, four groups, and two output channels. Its design corresponded to the "Large Basic Unit according to AK 3" and it met the conditions of the corresponding German standard. All inputs and outputs were balanced and floating, but the circuit inside the console was unbalanced. The maximum output level was +6 dBm, which is very low by present-day standards. The only transistors available at the time, however, were Germanium transistors. Nevertheless, transistors had cast off the stigma of amateurishness once and for all. Things had gotten off to a good start.

The development of silicon transistors then opened the way for more powerful amplifiers. Neumann built such devices and began manufacturing mixing consoles which, in electrical and mechanical terms, made customers' wildest dreams come true. Neumann enjoyed a great deal of success with this technology and delivered several hundred custom-made mixing consoles to numerous German and European radio and television broadcasting corporations, movie and recording studios, theatres, opera houses, and concert halls.

Development progressed with the realisation of computer-controlled switching equipment. In the late seventies, for example, Neumann equipped the main control room of what was then the radio station RIAS-BERLIN with a computer-controlled routing system. Other objectives were mixing consoles that permit

ted storage of static settings, for example, settings for microphone amplifiers, equalisers, controllers, and connecting points. This reduced set-up time considerably. Neumann delivered consoles of this type to the Schiller-theater and the Theater des Westens, both of which are theatres in Berlin. The first broadcasting corporation to accept delivery of a console of this type was Hessischer Rundfunk.

For the time being, continuing automation of master control board equipment reached its zenith in the N 7000 series, which offers fully automated operation, for example, through static and dynamic storage of all values and time-code-driven automation of motor controllers and VCA pan pots. Consoles of this type were delivered to the Berlin Philharmonic and several broadcasting corporations, as well as the Media Centre of the German Federal Defense Forces.

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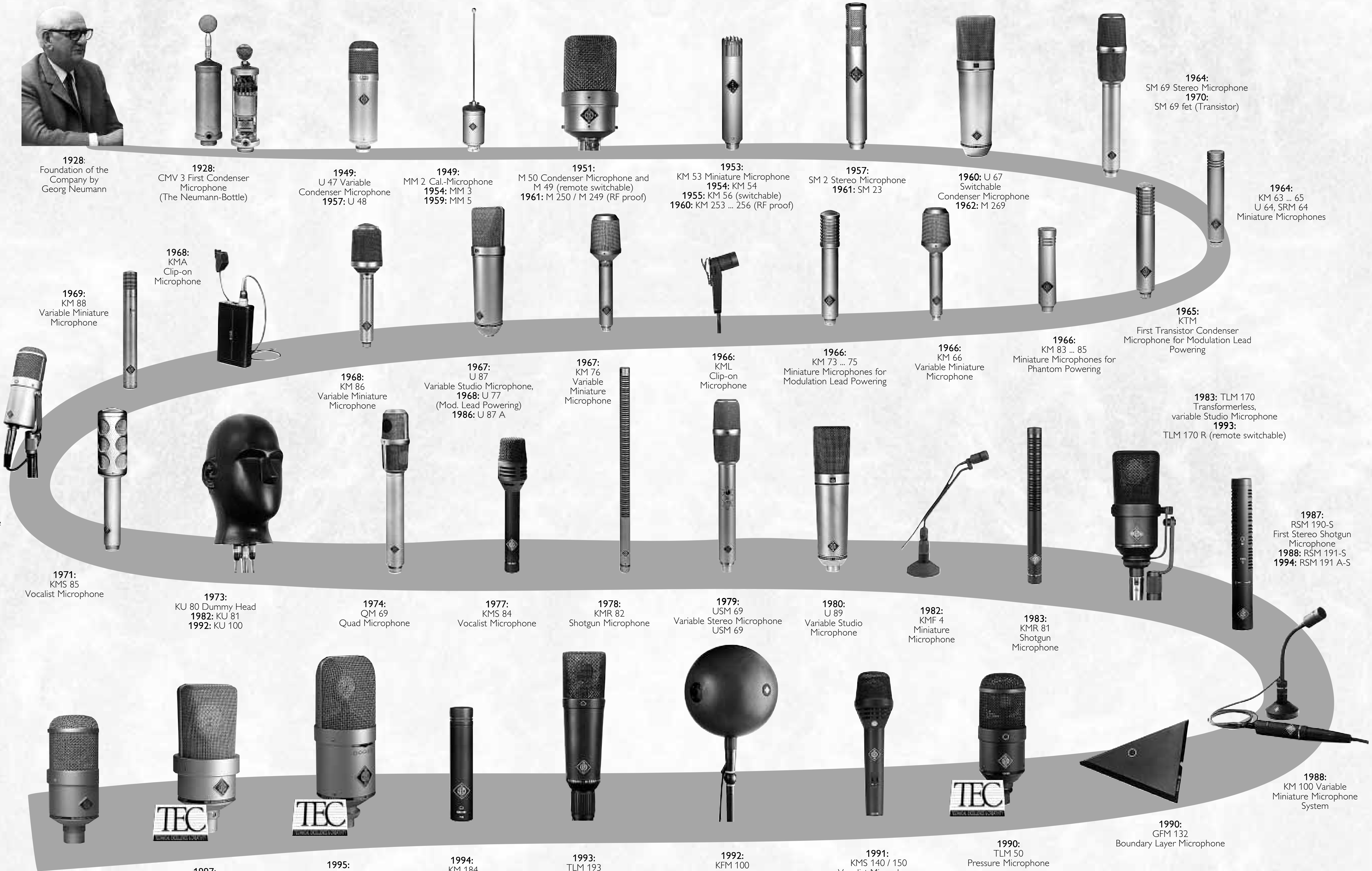


1928: Foundation of the Company by Georg Neumann

1928: CMV 3 First Condenser Microphone (The Neumann-Bottle)

1949: U 47 Variable Condenser Microphone
1957: U 48

1949: MM 2 Cal.-Microphone
1954: MM 3
1959: MM 5

1951: M 50 Condenser Microphone and M 49 (remote switchable)
1961: M 250 / M 249 (RF proof)

1953: KM 53 Miniature Microphone
1954: KM 54
1955: KM 56 (switchable)
1960: KM 253 ... 256 (RF proof)

1957: SM 2 Stereo Microphone
1961: SM 23

1960: U 67 Switchable Condenser Microphone
1962: M 269

1964: SM 69 Stereo Microphone
1970: SM 69 fet (Transistor)

1964: KM 63 ... 65 U 64, SRM 64 Miniature Microphones

1965: KTM First Transistor Condenser Microphone for Modulation Lead Powering

1966: KM 83 ... 85 Miniature Microphones for Phantom Powering

1966: KM 66 Variable Miniature Microphone

1966: KM 73 ... 75 Miniature Microphones for Modulation Lead Powering

1966: KML Clip-on Microphone

1967: KM 76 Variable Miniature Microphone

1967: U 87 Variable Studio Microphone,
1968: U 77 (Mod. Lead Powering)
1986: U 87 A

1968: KM 86 Variable Miniature Microphone

1968: KMA Clip-on Microphone

1969: KM 88 Variable Miniature Microphone

1969: U 47 fet Condenser Microphone

1971: KMS 85 Vocalist Microphone

1973: KU 80 Dummy Head
1982: KU 81
1992: KU 100

1974: QM 69 Quad Microphone

1977: KMS 84 Vocalist Microphone

1978: KMR 82 Shotgun Microphone

1979: USM 69 Variable Stereo Microphone USM 69

1980: U 89 Variable Studio Microphone

1982: KMF 4 Miniature Microphone

1983: KMR 81 Shotgun Microphone

1983: TLM 170 Transformerless, variable Studio Microphone
1993: TLM 170 R (remote switchable)

1987: RSM 190-S First Stereo Shotgun Microphone
1988: RSM 191-S
1994: RSM 191 A-S

1988: KM 100 Variable Miniature Microphone System

1990: GFM 132 Boundary Layer Microphone

1990: TLM 50 Pressure Microphone

1991: KMS 140 / 150 Vocalist Microphone

1992: KFM 100 Spherical Surface Stereo Microphone

1993: TLM 193 Studio Microphone

1994: KM 184 Miniature Microphone

1995: M 149 Tube Tube Microphone

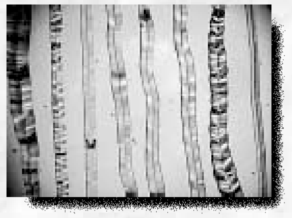
1997: TLM 103 Large Diaphragm Microphone

1998: M 147 Tube Tube Microphone

Refinements in Phonographic Technology

Up until around 1953, Neumann built disk-cutting lathes for phonograph records with a constant groove pitch. Between 1953 and 1955, Neumann developed a method of varying the groove pitch depending on the recorded amplitude. To this end, an additional playback head was mounted on the tape deck. This additional playback head determined the groove amplitude to be recorded approximately one half-rotation of the turntable in advance and fed this value to the cutting lathe as a control signal via a corresponding drive amplifier. Of course, this also required a separately variable pitch drive. For the first time, this made it possible to extend the playing time of an LP phonograph record to approx. thirty minutes.

So far the records had been monophonic disks made using lateral recording. In 1956, Neumann debuted its first stereo disk-cutting lathe, the ZS 90/45, which supported both lateral and vertical recording. The lathe was set up to cut the two stereo channels into the two flanks of the groove at a 45° angle. Over the years, other disk cutting lathes were developed, the quality of which improved continually. These were all electrodynamical feedback cutterheads. This model series continued with the SX 45, SX 68, SX 74 and finally the SX 84.



Many companies made a name for themselves with their products on the disk cutting market. These included, for example, Ortofon, Westrex, Scully, Fairchild, Dauphine, and others. By the end of the fifties, Neumann was the only company left that could deliver complete tape-to-disk transfer equipment. Neumann saw this position as a serious obligation to continue refining phonographic technology. This was reflected in the refinement of the disk cutting lathes and improvement of the cutting procedure.

One interesting phenomenon in this connection is the tracing distortion that results from the difference in geometric shape between the tool used to cut the grooves and the playback stylus. The cutting stylus is shaped like a spade, while the playback stylus is spherical. During playback, this results in tracing distortion, which mainly contains the 2nd harmonic. In 1968, Neumann built the Tracing Simulator that solved this problem.

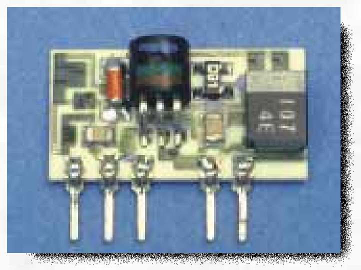
In the early seventies, Neumann successfully developed, in conjunction with TELDEC, a mechanically recorded video record that was played back via a pressure pickup. The experience gained in this connection led to another significant improvement in the process of cutting phonograph records. In the beginning, phonograph records were cut in bee's wax and for years thereafter in a phonographic foil coated with nitro-cellulose lacquer. Neumann introduced the DMM technology, in which the phonographic foil was replaced by copper foil, resulting in **D**irect **M**etal **M**astering, **DMM**. This resulted in substantially improved pulse fidelity of the recorded signal, which represented another significant improvement in the sound quality of phonographic records.

One Step Ahead Again: The TLM Technology

At the 1983 AES-Convention in Amsterdam, Neumann unveiled a brand new series of microphones with refined circuitry: the **T**ransformer**L**ess **M**icrophones of the "fet 100" series. The first representative of this series was the switchable TLM 170 with five directional patterns from which to choose. It used the same dual-diaphragm capsule as its somewhat older, transformer-equipped brother, the U 89.

Each microphone represented a considerable improvement in the common dynamic range of studio microphones at its respective time of introduction. Their electronics evidenced lower residual noise and, simultaneously, higher modulation levels than predecessor models. Furthermore, they were also a novelty in the market because they were the first to provide wide-angle cardioid and hypercardioid directional patterns in addition to the omnidirectional, cardioid, and figure-eight patterns common at the time.

The "especially open, free sound " of the TLM technology, which made it possible to transmit fine structures "as if a curtain had been pulled aside", encouraged Neumann to quickly equip other microphones with this system.



In order to be able to fit the complex circuitry into miniature microphones, however, it first took an additional development step: hybrid technology. This technology even made it possible to incorporate all electronics right in the capsule housing, thus giving rise to the "active capsules" of the KM 100 series.

So Neumann's miniature microphones not only took another clear step toward improved technical data, but now the capsules could be used with the help of accessories such as goosenecks, stand mounts, various cables, and tilting devices without electro-acoustic loss.

This miniature microphone family now comprises seven different capsules with all customary directional patterns. These also include stereo mounts for XY, ORTF and MS recording techniques.

The Specialists

Besides the aforementioned dummy head, in 1992 the KFM 100 Spherical Surface Microphone was introduced for an additional stereo recording method.

This microphone had two small, high-quality condenser capsules arrayed on the diameter of a head-sized wooden sphere. In the GFM 132 Boundary Layer Microphone, these capsules had been optimised for sound received at oblique angles. Thus the KFM 100 was a microphone for especially natural stereo recordings with tremendous

acoustic depth, making it ideal for miking highly complex acoustic fields, such as those found in churches and large halls.

Especially for outdoor recordings the RSM 191 stereo shotgun microphone was developed. The recording angle of this MS combination can be adjusted for the most diverse recording situations.

Upheaval Everywhere

These dynamic developments in the area of capsule technology and circuitry coincided not only with turbulent upheavals in global politics, but also with changes throughout the Neumann Company's corporate structure. For three decades, the company's Charlottenstrasse headquarters in Berlin near the Allied border checkpoint "Checkpoint Charlie" had stood at the edge of Western Europe. After the fall of the Berlin Wall in 1989, Neumann

suddenly found itself thrust into the centre of Berlin. The consequence: costs climbed dramatically overnight and ultimately the company's building was to be torn down to make way for a planned skyscraper.

The "politics in microcosm" within the company, however, was also good for a few surprises. The Neumann family, which had continued to hold a controlling interest in the company after Georg Neumann's demise in 1976, decided to sell its shares. TELDEC, which in turn now belonged to Warner Brothers, had been an additional owner since the early seventies. After negotiation with several prospective buyers, the Neumann family decided to turn the company over as a whole to a similarly structured, family-run German company that also has experience in the studio market: Sennheiser electronic GmbH & Co. KG.

So 1 January 1991 marked the start of a new chapter in the 62 year history of Georg Neumann GmbH, Berlin. This coincided with two fundamental changes in the market and thus was not without consequences: Since the mid eighties, traditional vinyl disk technology had been increasingly replaced by compact discs. Automation and digitisation in mixing console technology demanded ever increasing development outlay with ever shorter product life cycles for the components.

Some of the last large consoles in N 7000 technology were installed in the Berlin Philharmony and in regional studios of the Austrian broadcaster ORF.

Since 1993 Neumann concentrates itself on studio microphones. Herewith lie the core competence, the tradition, and 70 years experience of Neumann, Berlin.

Neumann Moves

In 1993, a decision was taken to move microphone production to the parent firm Sennheiser, located north of Hannover.

Now it was time to break camp and make a "fresh start" at a new location. This location is in Ollenhauerstrasse on the Northwest side of Berlin, not far from Tegel Airport. At Sennheiser, in the meantime, a separate "Neumann

Production Hall" was erected with state-of-the-art machinery and manufacturing equipment. Thanks to intense training measures, within a very short time it was possible to manufacture the entire line of microphones and accessories at the high level of quality which the world has come to expect and appreciate.

New Objectives – New Microphones

Despite all of these very dramatic changes, development of new microphones continued at the usual pace. In 1993, for example, Neumann launched the TLM 193 large diaphragm microphone. Limitation to those factors that are essential for recording quality, in conjunction with uncompromising streamlining of production, resulted in a new microphone category. This was a studio microphone which, by virtue of its low price, for the first time reached a demanding new set of customers who until then had never even dared dream of owning a "real Neumann". This marked the advent of a new generation of microphones, which was continued one year later with the KM 184. In this connection, Neumann is especially proud of the fact that not only do these microphones have the technical specifi-

cations associated with "real studio microphones", but they are also part of the continual, uncompromising improvement of these values. For the time being, the zenith of this development is marked by the TLM 103, which was launched in 1997 and received the TEC Award in 1998. For now, its residual noise of just 7 dB-A makes it the "quietest" studio microphone on the global market.

Back to the Tubes

The assertion above that the U 67 was Neumann's last tube microphone is not entirely correct.

Down to the present day, the development of semiconductor circuitry has resulted in tremendous improvements in specifications. There has also been amazing improvement in the reliability of all components. Quality and utmost technical complexity have become commonplace. Equipment available only to professionals a few years ago is now available for relatively little money.

Nevertheless, one "old-fashioned" component has, despite a brief slumber, never disappeared, especially in the studio sector: tubes. First they became popular in power amplifiers, where they could bring their pleasant sounding qualities to bear, then the clamour for a microphone revival became increasingly loud.

In 1995, Neumann responded with its M 149 Tube. The "49" in the name is no accident, since this large diaphragm microphone with nine switchable directional characteristics falls back on distinguished ancestors through its use of the K 47/49 capsule and its design. The circuitry is modern, however, despite the tube impedance converter which determines the sound. The output stage contains a transformerless, solid-state amplifier that can handle high modulation levels for driving even long microphone cables. This was always a problem with this microphone's ancestors, since cable material and length were always unforeseeable factors affecting the resulting sound.

1998 – Neumann Berlin's 70th Anniversary, Georg Neumann's 100th Birthday

At the end of 1998, the year which marks the seventieth anniversary of Neumann Berlin and the one-hundredth birthday of Georg Neumann, the M 149 Tube has finally fostered offspring. The M 147 Tube is limited to the most frequently required cardioid directional characteristic, but has at its core the same capsule and the same circuitry as the award-winning M 149 Tube.

Neumann: A Name Stands for Quality and Precision

Despite all the progress in machines and production technology, manufacturing a high-quality microphone involved a great deal of handicraft, upon which the quality of these transducers and a reputation such as Neumann's ultimately depend.

Capsule Building - A Science in Itself

The performance of the condenser microphone, now manufactured in an extremely wide range of models, remains largely reliant on the precision engineering involved in capsule production.

The common centre electrode found on a double diaphragm capsule contains a large number of critical drill holes, some of which are blind. The depth of these blind holes determines the volume of air trapped behind the diaphragm. This volume, which inhibits the movements of the diaphragm, determines the transducing capability of the condenser microphone.

The dimensions of the holes, and their accurate machining becomes even more crucial when the electrode is produced in two halves. With this design the two halves of the capsule can be electrically connected, and similarly separated, by means of an isolating intermediate layer, thereby making it possible to switch the directional characteristic with the available polarisation voltage.

To smooth the surface of the electrodes two different processes are employed. For microphone capsules whose surface lie on one plane a lapping process can achieve a surface flatness of 0.3 μm and a plane parallelism of +/- 1 μm between the front and the back of the electrode. In some cases a capsule's surface may be in two planes. This may be because the distance between the diaphragm and the electrode has already been determined by the second plane of the electrode. In such cases the finishing is performed on special lathes.

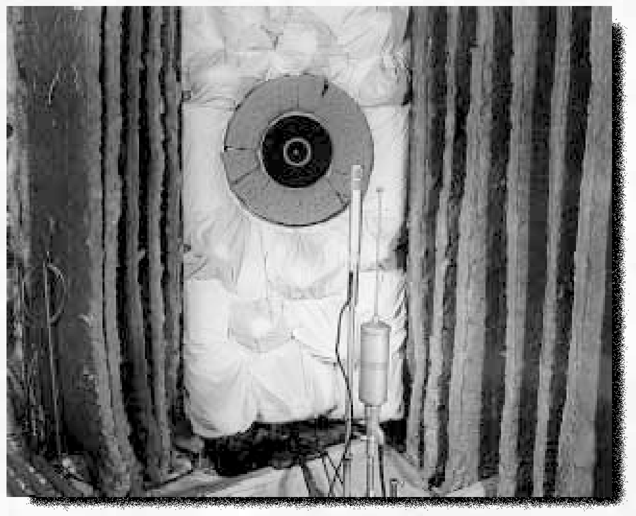
After lapping or lathe finishing, the holes must be deburred, followed by a visual inspection using a powerful microscope.

Diaphragms are made from a 6.3 µm thick polyester foil, such as Mylar. This is first attached to brass rings, then put into a container which holds it while gold is applied under vacuum to a uniform layer 300 Angstroms thick (0.03 µm). The external diameter of the capsule is approximately 34 mm. The diaphragm is fitted approximately 40 µm in front of the electrode and is 6.3 µm thick. When a sound pressure of 1 Pa is applied the diaphragm movement is no more than 10 nm. By comparison, the wavelength of violet light is 400 nm.

The mechanical advantages being achieved under these microscopic proportions is best put into perspective by illustrating thus: if a microphone capsule were to be given a scale on which the amplitude for 1 Pa were represented by 1 mm the capsule under manufacture would have to have a diaphragm spacing of 4 m, and the diameter of the capsule would be more than 3 km.

One type of capsule, the KK 88 from the KM 88 microphone, uses pure nickel as the diaphragm material 0.0007 mm thick (0.7 µm).

On assembly of the capsule aluminum foil spacer rings, 40 µm thick are attached to the middle and the edge of the electrode. The lead-in contact for the polarisation voltage is fitted in the centre. This is an assembly device that enables the capsule to be directly connected to a test instrument, with which the capacitance is measured and the mechanical strength of the diaphragm tested. This is done by measuring the change in the basic capacitance after the polarisation voltage has been applied.



Quality Must Be Measurable

To meet the operating conditions encountered in the studio the microphones are subject to testing throughout their manufacture. The capsules alone undergo more than 50 different tests before final assembly.

Since the very beginning in 1928 Neumann condenser microphones have always operated on an audio frequency circuit, with the capsule consequently acting as a very high-impedance generator, rendering it highly sensitive to moisture. And as moisture represents one of the most common operational hazards of a warm recording studio, Neumann has paid great attention to all aspects of insulation.

Quality control devoted to this aspect includes a moisture chamber, in which capsules are placed until both the diaphragm and microphone body are dripping wet. Even under these conditions insulation resistances to the order of 20 x 10^6 Mohms are measured in the capsules.

Another test is to cool the microphones to slightly above freezing point and then place them in a chamber with 100% humidity, at a relatively high temperature. The spontaneous moisture formation that follows infiltrates not only the capsule but the entire electronic circuitry. It would have to be an extremely uncomfortable studio to recreate such conditions to say the least, but just in case, we would like to point out that every type of Neumann condenser microphone will pass this test.

Legend

(from left to the right)

P. 2 Georg Neumann
Reisz-microphone

P. 3 Erich Rickmann – Co-founder of the company
Capsules for the CMV 3
CMV 3 – The first condenser microphone (1928)

P. 4 Disc cutting machine, belt driven (in the 30's)
Disc cutting machine, direct driven (in the 30's)
Microphone test setup – Calibration of microphones with pistonphone
Stability cells (1947)

P. 5 The first larger workshop of the company at the Brandenburgstrasse, Berlin (about 1930)
Double diaphragm capsule of U 47 (1947)
U 47 – The first switchable pattern condenser microphone (1947)

P. 6 M 49 – The first remote-switchable microphone (1951)
Miniature microphone KM 53 (1953)
SM 2 – The first stereo microphone (1956)
Attenuation recorder P 2 (1934)

P. 7 Measuring microphone MM 2 (1949)
Large diaphragm microphone U 67 (1960)
Large diaphragm microphone U 87 A (1967)

P. 8 Small diaphragm microphone KM 84 (1966)
Vocalist microphone KMS 85 (1971)
Shotgun microphone KMR 81/82 (1978/1983)
Dummy head KU 80 (1973)
Dummy head KU 100 (1992)

P. 9 Mixing consoles at the theatre 'Theater des Westens', Berlin
Mixing consoles of the N 7000 series at the Berlin Philharmonic

P. 12 Microscope picture of record grooves
Disc cutting head SX 74
Complete tape-to-disk transfer equipment
DMM-disc cutting equipment

P. 13 The transformerless microphone TLM 170 R ("fet 100" series)
Hybrid circuit
Active capsules AK 40 and AK 20 of the KM 100-series (1988/1996)
Spherical surface microphone KFM 100 (1992)
Boundary layer microphone GFM 132 (1990)

P. 14 Stereo-shotgun microphone RSM 191 (1988)
Company's headquarters in Charlottenstrasse, Berlin
Company's headquarters in Ollenhauerstrasse, Berlin

P. 15 Large diaphragm microphone TLM 193 (1993)
Miniature microphone KM 184 (1994)
TLM 103 – The "quietest" studio microphone (1997)

P. 16 M 147 Tube (1998)
Tec Award for the large diaphragm microphone M 149 Tube with K 47/49-capsule (1997)

P. 17 Capsule workshop – Mounting the diaphragms onto capsule body (1996)

P. 18 Microphone-lab – Mounting the gold-plated diaphragms onto electrodes (in the 50's)
Microphone-lab – Assembly of U 47 capsule heads (in the 50's)
Microphone-lab – Static measurement of U 47/M 49-capsules (in the 50's)
Measuring equipment for free-field microphone measurement (in the 50's)

P. 19 Anechoic measuring room (1996)
Capsule workshop – Mounting the diaphragms onto capsule body (1996)
Capsule workshop – Assembling the capsule heads (1996)
Capsule workshop – Equipment for static measurements (1996)

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