 BY RICH TOZZOLI

The Anatomy of a Mic

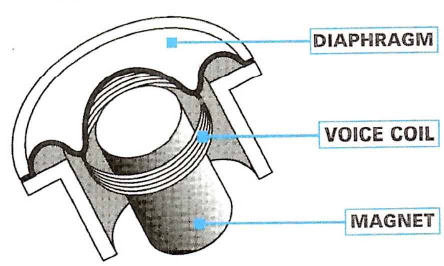
The magic of microphones is generated by some relatively simple mechanical parts.

SHURE SM57 DYNAMIC MICROPHONE

Microphones seem to work by magic. Sing or play into one, and it's almost as if an invisible force is capturing the sound and making it come out of a speaker. But the "magic" inside a mic is actually due to the incredible yet simple mechanical actions of its various parts.

The microphone—the word is derived from two Greek roots: *mikros* (small) and *phone* (sound)—was originally developed for use in telephones. In fact, every time you talk on a phone today, you're using a mic.

The fundamental job of any microphone is to act as a *transducer*, a device that converts one type of energy into another. In this case, acoustic sound is being converted into electricity. The *element* inside the mic's body, or *housing*, reacts to sound pressure waves, such as those produced by your voice or instrument, and turns them into electrical voltage. The resulting electrical *signal* travels on a wire from the mic into an amplifier, which raises the signal's volume level (or *gain*) so that it generates enough energy to make a loudspeaker vibrate.



But while all mics serve the same basic purpose, they come in several varieties. Let's look at how each kind works.

DYNAMIC MICROPHONES

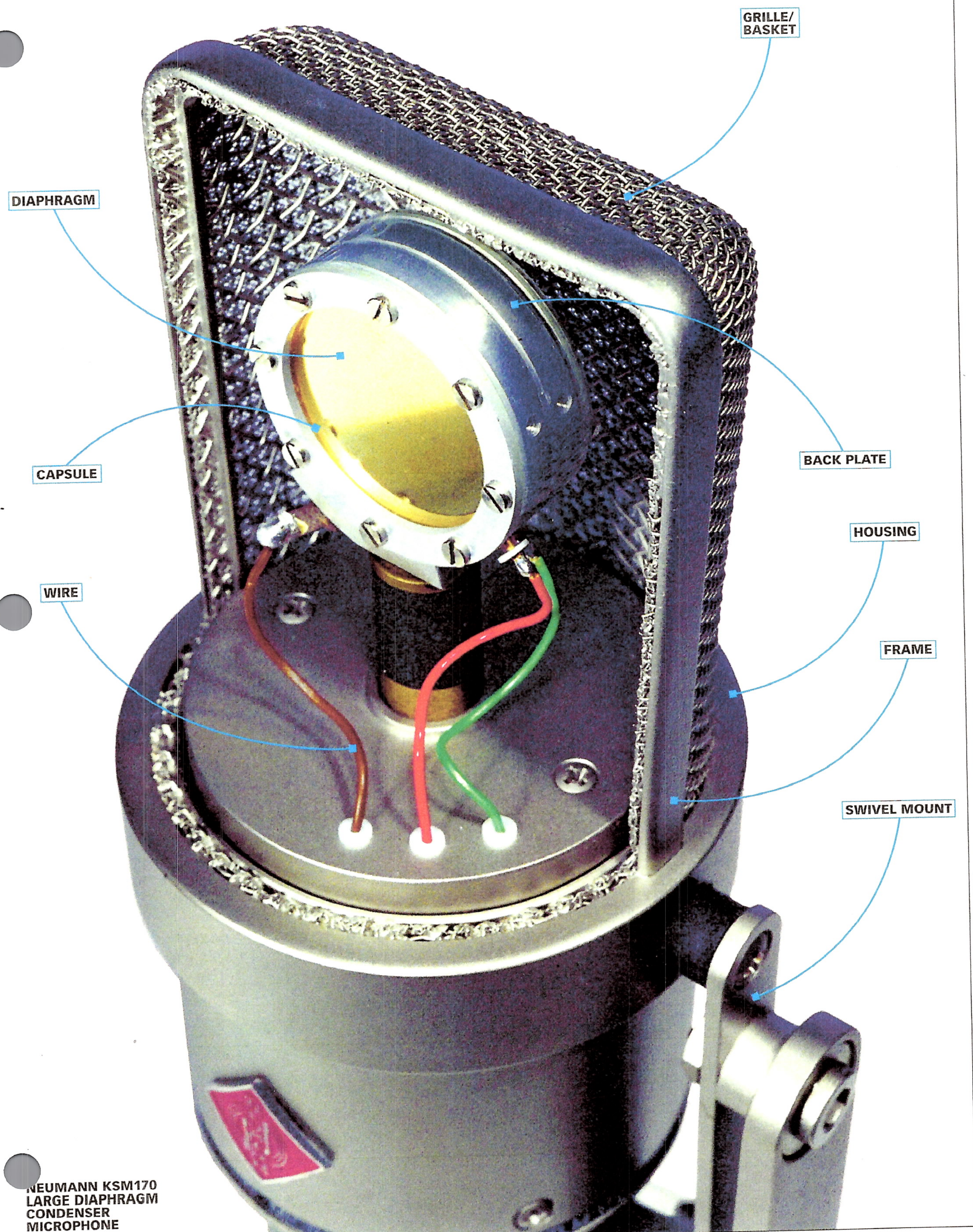
The *dynamic* (or *magneto dynamic*) is one of the most common types of microphones used for music. Dynamic mics work by a principle called *electromagnetic induction*. Don't worry: It's not that hard to understand! A small *induction coil*, which is suspended inside a magnet, is connected to a small *diaphragm*. When you speak, sing, or play into this kind of mic, the sound waves hit that diaphragm, causing it to vibrate. Those vibrations then move the coil inside the magnetic field, and that motion generates a small amount of electrical current—all due to the principle of electromagnetic induction. (See, it wasn't so bad.) Interestingly, dynamic microphones work in the exact reverse way loudspeakers do. Electrical energy causes a speaker to vibrate, and that vibration generates sound waves, which travel through the air to your ears.

Dynamic microphones such as Shure's SM58 and SM57 and Sennheiser's MD 421 and 441 are known to be very robust and can stand up to a lot of pressure, so they work well for loud sounds such as drums, brass, and guitar amplifiers, as well as vocals. Their relatively simple design makes them great for onstage work. Dynamic mics can be mounted on stands or hand-held.

A dynamic mic's rugged metal housing protects the element, which is isolated from the housing by shock-absorbing components. These keep the element from transmitting unwanted vibrations that might be caused by handling the mic. A removable metal screen called the *grille* sits at the top of the housing. It, along with soft foam covering the element, keeps dirt and moisture away from the diaphragm while letting the airborne sound waves get through. On mics designed for vocals, the foam may be thicker so that the singer's breath doesn't cause those percussive popping sounds you've heard on countless school announcements, called *'plosions*.

CONDENSER MICROPHONES

Another common type of microphone is called the *condenser*. Although, like dynamic mics, condenser—or *capacitor*—designs



NEUMANN KSM170
LARGE DIAPHRAGM
CONDENSER
MICROPHONE

convert waves passing through the air into electrical signal, they use different circuitry and need a battery or external power to work.

When you make a sound into a condenser mic, the waves enter and strike two plates, the first of which is made of a light material and is called the *diaphragm*. As the diaphragm vibrates, the distance between it and the second plate—called the *back plate*—changes, which in turn changes the *capacitance* (the amount of electrical charge). In order for this to work, there must be electrical voltage between the two plates; hence the need for a power source.

For today's condenser mics—especially the ones used in professional applications—the necessary voltage is delivered through the same cable used to connect the mic to the audio system. This signal, known as *phantom power*, is usually a 48-volt current. You may have seen a phantom power switch on a mixer, recorder, or microphone preamp; if you have a condenser mic connected and it's not picking up any sound, check that switch! If it's off, the mic can't do its job.

Condensers are generally more sensitive to quiet sounds than their dynamic counterparts, which is one reason they're more common in studio than in live applications. They come in two main types: *Large diaphragm* condensers like the Neumann KM147, AKG C414, and Shure PG27 work well in many different applications and are the most popular choice when recording vocals in a studio. *Small diaphragm* condensers—which are often tube-shaped—are effective on stringed instruments and percussion.

RIBBON MICROPHONES

Have you ever seen those old pictures of Elvis singing through a giant microphone back in the 1950s? Well, most likely, that was a *ribbon mic*.

Ribbon mics are actually a type of dynamic mic, yet many models are as sensitive as condensers. A small, thin strip of ribbon is suspended between two poles of a magnet. Sound waves coming into the mic move that ribbon, which acts as the diaphragm. Electromagnetic induction generates voltage, which, as you now know, creates electrical signal.

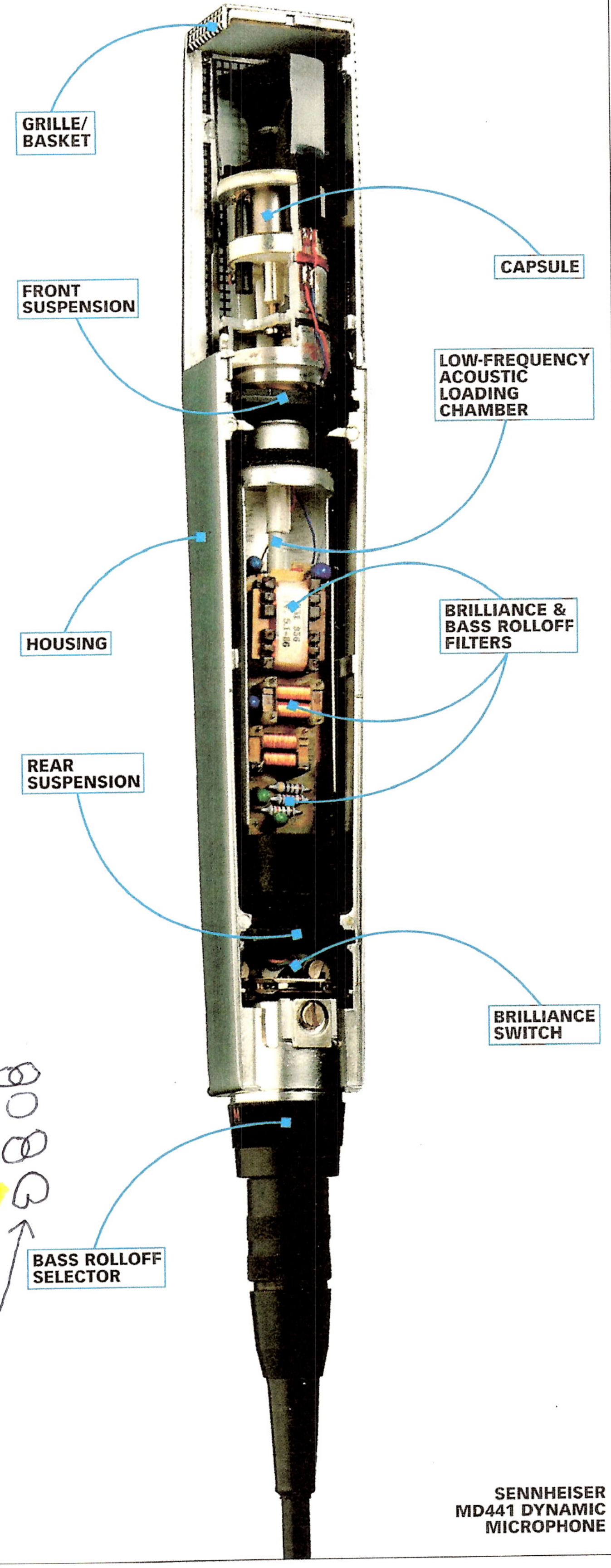
Although ribbon mics have always been prized for their "warm," natural sound, the older models were very fragile. However, today's ribbon mics are much sturdier, and can even be found onstage at loud rock shows.

POLAR PATTERNS

Most good-quality mics come with a little drawing of a circle covered by a squiggly line. This shows the mic's *polar pattern* (and it looks a little like a map of the North Pole). There are four common polar patterns, and each tells you which way to point the mic in order to pick up the most sound. Most mics are designed to pick up in only one pattern, but some models can be switched to operate in two or more.

The most common pattern is *cardioid*: The mic picks up the sounds made directly in front of it, but ignores most of the waves coming from the side or back.

A *hypercardioid* pattern is even more tightly focused on the sound coming from in front of the mic. It's especially good for live vocals because the mic can pick up a singer's voice without amplifying a competing sound, such as a nearby guitar.



SENNHEISER MD441 DYNAMIC MICROPHONE

A *bidirectional* polar pattern picks up sound equally well on both sides of the mic. It's also known as *figure-8*.

An *omnidirectional* pattern picks up sound in a full 360-degree circle around the mic; it's good for capturing ambience or recording an ensemble, but, like the figure-8, has limited use for live music. That's because omnidirectional or bidirectional mics pick up the sound of *everything* around them. If you used them for an amplified concert, not only would all the instruments get mixed together on each mic, but there would be a horrible squeal known as a *feedback loop* as the mics capture sound from the speakers while the speakers generate sound captured by the mics!

SPECIALIZED MICROPHONES

While dynamic, condenser, and ribbon are the most common mics for music, there are other varieties. A *shotgun microphone* is the most highly directional of all. Ever see a picture of a TV show recording, where the soundman is hanging a long, thin microphone just above the actors? That's a shotgun mic. Its microphone element is housed at the very tip of a long tube with slots cut along its side. These slots help eliminate much of the sound coming at the mic from the sides, allowing the element at the tip to isolate a single sound in a noisy environment.

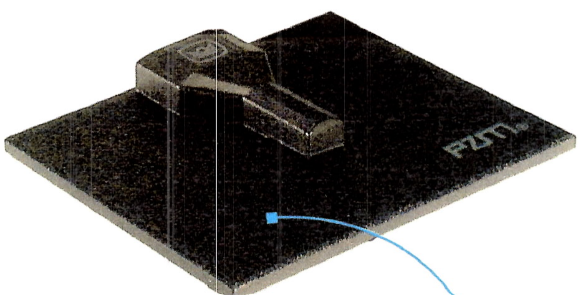
Another type of condenser mic, often found onstage in musical theater productions, is called a *boundary* microphone or PZM (which stands for *pressure zone microphone*). These designs feature a small reflective *boundary plate* with a mic mounted on it. The mic actually picks up the boundary plate's vibrations—not air pressure like a typical mic. These mics' flat housing lets them be placed on a surface like a stage, capturing sound without getting in anyone's way.

CHANGING A MIC'S SOUND

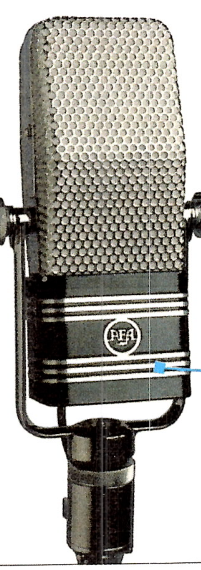
You would think that mics are designed to capture sound exactly as it appears in nature, but in truth, most mics change, or *color*, the sound in some way. Experienced audio professionals know this and usually choose specific mics for their individual qualities.

Several factors influence the sound coming through any mic. The first is its position relative to the source. We already mentioned polar patterns. When a mic is pointed slightly away from the source (or *off axis*), the sound will change. In some applications, this actually works better than a more direct position. Another factor is the distance between the source and the mic. Almost all mics have something called *proximity effect*. Moving the source very close to the mic boosts bass, which may or may not be what you're looking for.

In addition to placement, some microphones feature small switches that change the sound. A *bass rolloff* switch reduces the amount of bass sent through the mic. A *pad*—found on many good-quality condenser mics—reduces the gain of the signal going to the amplifier. It comes in handy when you're using the mic to capture something loud like a guitar amp, drum set, or herd of rampant tuba players. T

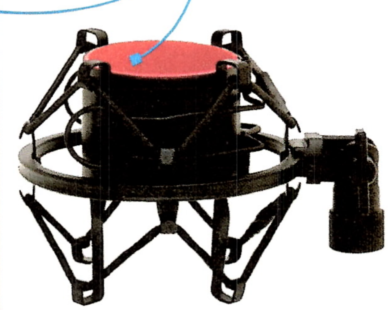


Boundary mics like the Crown PZM-30D pick up vibrations transmitted through surfaces and are often used on Broadway stages.



This modern recreation of a vintage ribbon mic by AEA is much sturdier than the models of old.

The slots along the side of a shotgun mic like this Sennheiser MKH416 prevent sounds from the sides from reaching the element at the tip.



Shure's KSM353 is a modern ribbon mic. The cage-like device below is known as a "shock mount." It's designed to isolate the mic from unwanted vibrations coming though the mic stand.