Episode Book

EPISODE #6715

How Ribbon and Boundary Microphones Actually Work

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SYNOPSIS

Dynamic and condenser designs dominate audio discussions, but rare microphone categories reveal a deeper map of transducer physics and surface placement. This breakdown examines the corrugated aluminium foil inside ribbon mics, the sixty-second phantom power decay window, and the mechanical figure-eight pattern. It also explores boundary microphones, tracing how flush mounting prevents comb filtering, how table size dictates low-end reproduction, and why boundary mics remain vulnerable to surface vibrations.

TRANSCRIPT



Corn

Less than one ohm. That's the impedance of the actual ribbon inside a ribbon microphone — a thin corrugated strip of aluminium, hanging between two magnets, putting out a signal so faint and so electrically hopeless that the microphone has to carry its own transformer just to be heard. That's Daniel's starting point.



Herman

It's a good one.



Corn

His question is basically this. Everyone learns two microphones — dynamic and condenser — and walks around thinking that's the whole map. But those are just two ways of turning sound into electricity. He wants the rest of the map: the rare technologies some people swear by, how each one actually works, and what it does to a voice that the big two don't. He names ribbon and boundary as his two curiosities.



Herman

He would.



Corn

And then there's the sleeper question at the end, the one that sounds like a vocabulary lookup — what's the actual difference between a boundary microphone and a conference microphone. That one turns out to be a category error wearing a tie, so we'll get there.



Herman

The map metaphor is right, actually, because the first thing to say is that Daniel's instinct is correct and the map everyone learns is wrong in a specific way. Dynamic versus condenser isn't a map of microphone types. It's a map of transduction — how the diaphragm's movement becomes voltage. Dynamic means a coil or a ribbon moving in a magnetic field. Condenser means a charged plate whose capacitance changes as the diaphragm moves toward and away from it.



Corn

Two mechanisms, and everything else is either a variant of one of those or something else.



Herman

Yes. And the binary is leakier than people realise before you even leave the mainstream. A ribbon is a dynamic microphone. An electret is a condenser with permanently stored charge instead of forty-eight volts of bias. A tube microphone — the Neumann M 147 uses the same K 47 capsule family as the U 47. The tube isn't doing the sensing, it's the impedance converter sitting after the capsule. Same ears, different mouth.



Corn

Neumann also likes to say "true condenser" as if electrets are somehow counterfeit, and by their own admission that's mostly marketing. Some early electrets lost their charge after a few years, which was a real problem, but the term has outlived the problem by a wide margin.



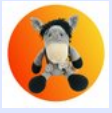
Herman

Right. So the sorting principle I'd propose — and I think this is what makes Daniel's question answerable instead of a museum tour — is a two-column split. Column one: different ways of turning sound into signal. That's a short list. Ribbon, which is technically a dynamic. RF condenser. Carbon. Piezo. Contact, throat, bone conduction. Column two: things that sound like a third technology but are actually a design or a placement. Shotgun is a directional capsule with a slotted interference tube stuck in front of it. Boundary is a mounting physics. Conference is a job description.



Corn

So half of the "rare microphone types" people list are neither rare nor types.



Herman

That's my read. We should start with the two Daniel named — the ribbon, which is a real transduction story, and the boundary, which is the opposite, a capsule doing something ordinary in an extraordinary place.



Corn

Start with the ribbon, then. The dynamic mic wearing a very expensive coat.



Herman

The ribbon is one of those designs where the elegance is in how little there is. You have a magnet assembly, and stretched between the poles is a strip of aluminium, corrugated like a tiny accordion so it can move freely. That strip is the diaphragm and the coil at once. Sound moves it through the magnetic field, and the voltage appears across its ends. There's nothing else in the signal path.



Corn

And no amplifier, no phantom, no charge. Just metal moving in a magnet field.



Herman

Just metal moving. Now here's the engineering problem, and it's a beauty. That ribbon is a single turn of wire, essentially — its impedance is under one ohm. You cannot drive anything with that. So inside the microphone there's a step-up transformer, something in the range of one to twenty up to one to forty, which lifts it to a few hundred ohms so a normal preamp can work with it. Even after the transformer the output is famously low.



Corn

Which is where the folklore starts. Every forum thread about ribbons has someone saying you need a special low-impedance preamp or the mic will sound wrong.



Herman

Thomann — the big European retailer — calls that an urban myth outright. The actual guidance is boring: the preamp's input impedance should be maybe five to ten times the microphone's output impedance. That's ordinary practice, not ribbon magic. People hear "low output" and translate it into "needs exotic electronics," and the two aren't the same thing. You need a quiet preamp with decent gain, because you'll be turning it up.



Corn

Now the part I find clever, which is the two-sided thing. The ribbon is open to the air on both faces.



Herman

That's the whole character of it, and it follows from the construction. A typical dynamic diaphragm is closed off at the back, so it responds to pressure — how hard the sound pushes. The ribbon hangs free. It responds to the difference in pressure between its front and back, which is called velocity — the air actually moving. And that gives you the figure-eight pattern by pure mechanics: sound arriving from the side pushes on both faces equally, and the ribbon doesn't move at all. A perfect null off to the sides. Sound from the front or back moves it fully.



Corn

No electronics doing that. The null is free.



Herman

The null is geometry. And the pattern has consequences for voice, and this is where I'd flag something. Figure-eight has the strongest proximity effect of any polar pattern — you get close to it and the bass swells. An omni pattern has none at all. Cardioid is in between. So a ribbon up close on a voice becomes a bass event.



Herman

The industry knew this at the dawn of the technology — the RCA Type 44 arrived in 1931, Olson and Anderson's design, and the 44-A shipped with a bass-cut setting labelled for voice. A physical switch on the microphone, existing purely to admit that the pattern it was born with is wrong for speech at close range. I love that. The microphone apologising for itself.



Corn

It's a settings menu from 1931. The 44-B and BX stayed in production until 1957, and the BBC ran ribbons across their studios for decades — the Coles 4038, which is the STC version, dates to the mid-fifties depending on which source you believe, 1953 or 1955.



Corn

And that gets us to the folklore I want to pin down, because there are two pieces of ribbon lore and I only half-believe one of them. The first is phantom power. The received rule is you never, ever send forty-eight volts to a ribbon.



Herman

Half-truth. The real story is more interesting. Modern passive ribbons mostly tolerate phantom fine — a correctly wired balanced cable puts the same voltage on both signal lines, so no net current flows through the ribbon. What kills ribbons is a miswired cable, where the phantom comes across asymmetrically, or a spike from patching in a live patch bay. And here's the detail nobody mentions: phantom power takes on the order of sixty seconds to decay after you switch it off. So the guy who powers down, then patches, is still gambling.



Corn

The danger window is a full minute of invisible voltage. That's the actual rule, and "never use phantom" is just the rule with the thinking removed.



Herman

There's a second column, too — active ribbons. Those have a phantom-powered buffer built in, and they want the forty-eight volts. They output near-condenser levels. So the blanket rule now forbids the correct treatment for an entire class of ribbon microphones, which is what happens to every blanket rule eventually.



Corn

The second piece of folklore is the sound. The silky, smooth, dark top end. "Warm." I want to know what that claim rests on.



Herman

Honestly? Retail copy. The listings for the old BBC-style ribbons say smooth, dark top end from vendor to vendor, and we found no measurements establishing it. The sibilance claims — that ribbons are gentler on esses — same situation. Unverified, repeated until smooth. There may be something real underneath, but as it circulates it's folklore.



Corn

So we tell Daniel: a ribbon gives a voice a figure-eight, a null at the sides, a big proximity bass, a low output that wants gain, and a reputation for smoothness that no one has measured.



Herman

That's the honest inventory. And one more honest thing — the figure-eight has a use nobody mentions for voice work. The null at the side is useful. You point the dead side at the noisy thing, the refrigerator hum or the open window, and the ribbon largely ignores it.



Corn

I'd trade the silk for the null, honestly. Silk is unmeasured. The null is physics.



Corn

That's the ribbon. Now the other one Daniel asked about, and it's a completely different kind of answer — because a boundary microphone is not a new transducer at all. It's a placement.



Herman

And it's one of my favourite pieces of physics in all of audio, because the payoff is a free lunch. Here's the setup. Take a normal omnidirectional microphone and put it above a table, in a room. What does it hear? The direct sound from your mouth, and then the reflection off the table, arriving a fraction of a millisecond later. Those two sum — and because of the delay, some frequencies add and some cancel. The response comes out with a comb across it. Comb filtering.



Corn

That's the hollow, phasey sound every conference recording has.



Herman

That sound. Now the same microphone, mounted flush on the table, or a few millimetres above it. At a rigid boundary, pressure is at maximum and particle velocity is at minimum. So the direct sound and the reflected sound arrive at the capsule in phase — no delay, no comb. And they sum coherently, which doubles the pressure.



Corn

Double the pressure is plus six decibels. The table hands you sensitivity for free.



Herman

Six decibels of gain that cost nothing but glue. And the pickup becomes hemispherical if the capsule is omni — half a ball sitting on the plate. That's the physics. Ed Long and Ron Wickersham studied the pressure zone from 1978, Ken Wahrenbrock built the first marketable version, Crown licensed it in 1980 and trademarked PZM — pressure zone microphone. Crown's directional variant was the Phase Coherent Cardioid.



Corn

There's a catch, though, and it's the catch that gives boundary mics their bad reputation in the field.



Herman

The surface has to be big. The plate needs to be comparable to the longest wavelength you care about — and voice wavelengths run to a metre or more. On a small plate, the free six dB shows up at the high frequencies and fades as you go down, so the mic sounds bass-light, thin. A boundary mic on a dinner-plate-sized plinth sounds like a transistor radio. The same mic on the actual conference table — a couple of metres of wood — is a different animal.



Corn

So the surface is doing the bass. The mic is only half the product.



Herman

The mic is the part you buy; the table is the part that works. One small distinction while we're here — the classic PZM hangs the capsule slightly above the plate, flush types sit in it. Hugh Robjohns looked at that and concluded there's no significant working difference. It's a construction preference, not a sonic one.



Corn

And the assumption people make — boundary means omni.



Herman

No. Shure's MX391 comes in cardioid, supercardioid, and omni. The boundary is the mounting; the pattern is whatever capsule you chose to mount. You can put a directional capsule at the surface and get a hemisphere with a preferred direction.



Corn

Which answers the practical question nobody asks until it's too late — what are these things bad at.



Herman

Everything that happens on the same surface they're mounted to. Table thumps, pen taps, paper rustle — the plate is their ear, so the paper is directly on the eardrum. Laptops get shoved in front of them. And a retailer's own Q&A says that picking up quiet talkers at six to eight feet stretches one. A boundary mic is a hearing aid for a table, not a room.



Corn

I want to say the thing we said about the sides of the ribbon — the null was free geometry. Here it's the opposite: the gain was free physics, and the noise is free physics too. Same coin.



Herman

And that is roughly why the boundary mic is a placement, not a species.



Hilbert

Hilbert's Anteater Trivia. Giant anteaters have disappeared from much of Central America and from Uruguay. I have never disappeared from a place, mostly because nobody has asked me to leave.



Corn

He'll be insufferable about that one.



Herman

Anyway. The plate is the ear. So — Daniel's actual question, the one he says he's always wondered: boundary versus conference microphone. And I want to answer it cleanly, because I think most of the confusion out there comes from catalogues, not physics.



Corn

My guess, before you say it: conference isn't a technology at all. It's a shelf in the shop.



Herman

That's it. A conference microphone is any microphone defined by the job — capturing several talkers in a room for an audience at the far end of a call. That product category includes boundary and tabletop mics, gooseneck mics on the table, beamforming table arrays and ceiling arrays, and — this is the invisible part — a stack of digital processing. Acoustic echo cancellation, noise reduction, automixing. The DSP is what actually makes a room work with loudspeakers in it. Not the capsule.



Corn

So a "conference microphone" is a boundary microphone plus a job plus about four algorithms.



Herman

Plus the algorithms, yes. Echo cancellation is the load-bearing one — without it, the far end hears themselves, and no capsule choice fixes that. Automixing matters too: with several open mics in one room, the automixer decides who's live. Then there's a human factor I find funny. Shure's own guidance leans toward goosenecks in conference rooms over tabletop boundary mics, and the reason is not acoustic. It's that people put papers and laptops over flat things.



Corn

The acoustics lost to stationery.



Herman

Papers cannot cover a gooseneck. That's a real design criterion from a real manufacturer, and it's about human behaviour, not frequency response.



Corn

So the actual difference, stated plainly for Daniel: boundary describes how a capsule is mounted. Conference describes what the whole system is for. A boundary mic is one ingredient in a conference system; a conference system can be built with no boundary mic at all; and a boundary mic used alone for one voice needs no DSP whatsoever.



Herman

Right. And the final nail — boundary mics get used where nobody is conferencing. Kick drums, floors, stage fronts. The technology found its way into places the product category never pointed at.



Corn

The placement escaped the job description.



Herman

It usually does.



Corn

Now the wider tour, before we let Daniel off — the different transduction methods, the short list from column one. Let's do them briskly. The RF condenser first.



Herman

The RF condenser is a lovely twist on the condenser idea. In a normal condenser, the capsule is a capacitor held at a high DC voltage. In an RF condenser, the capsule is part of a radio-frequency oscillator running at around eight megahertz. Sound changes the capacitance, which shifts the oscillator's signal, and that gets demodulated back down to audio inside the microphone.



Corn

Why would anyone do that? It sounds like turning a simple thing into a radio station.



Herman

Because of what it does to the capsule's electrical life. The capsule sits at low impedance with a bias under ten volts, instead of the high-impedance setup of a standard condenser, which is why RF designs resist humidity better. Sennheiser brought it to market with the MKH 104, around 1961 or '62, and the MKH series still works this way. The humidity resistance is the reason people reach for them.



Corn

Carbon next. The one everybody under seventy has heard a thousand times without knowing the name.



Herman

Every old telephone. A diaphragm presses on a bed of carbon granules; sound squeezes the pile, its resistance changes, and that modulates a current you supply from outside. The remarkable property is that it's an amplifier with no amplifier — the supplied current gives you gain for free. The cost was a narrow, noisy response. That's the telephone sound. Broadcasting moved on from carbon in the early 1920s, once better microphones arrived.



Corn

Piezo and crystal.



Herman

A ceramic element — PZT, lead zirconate titanate — or an actual crystal that generates a voltage when it's flexed. You can stick one to almost anything and get a signal out. The problem is the output impedance is enormous; it wants to see over a megohm. Plug it into a modern low-impedance input and it sounds thin and harsh. Crystal mics were popular in the middle of the last century, cheap and with a high output voltage, and they faded when transistor inputs replaced valve ones, whose high-impedance inputs had suited them.



Corn

So the technology didn't die. Its required neighbour did.



Herman

That's a neat way to put it. Contact mics survive, but they want a proper buffer.



Corn

Throat and bone conduction. I have opinions about the sound of these.



Herman

Everyone does, because they sound wrong in a specific way. A laryngophone presses against the throat and picks up the vibration of the larynx itself; bone conduction does the same at the skull. Total indifference to ambient noise and wind — that's why military and



Herman (continued)

emergency services still use them — but what they capture is the voicing, not the shaping. The mouth, the tongue, the lips are the articulation, and none of that is in the throat. So speech comes out muffled, like it arrived through a wall.



Corn

Intelligible but wrong. The telephone's uncle.



Herman

The British credited Charles Edmond Prince with the WWI aircraft throat microphone — open cockpit, engine noise, wind; a normal mic was useless and a throat mic heard the pilot regardless.



Corn

And the lab curiosities. Keep it quick.



Herman

Laser microphones — a laser Doppler vibrometer reads the vibration of a window pane, and the window becomes your diaphragm. Theremin's Buran system did the same trick with infrared decades before the laser version; the long-range spy claims you see in articles are, as far as I can tell, unsourced. Fibre-optic microphones get used inside MRI rooms, because a strong magnetic field that ruins every other transducer doesn't touch a light beam. And ionic or plasma microphones use a corona discharge as the sensor — no diaphragm at all, air ionised between electrodes — with sensitivity so low and electrode wear so bad that it's stayed a laboratory curiosity.



Corn

A microphone with no moving parts, rejected for wearing out its non-moving parts.



Herman

The electrodes erode. That's the barrier.



Corn

So let's close the loop on the map we promised Daniel. The different transduction methods — dynamic including ribbon, condenser including electret, tube, and RF, carbon, piezo, contact, and the optical curiosities — that's basically the whole list. Everything else people name is a pattern, a placement, or a job.



Herman

A short column one and a very long column two.



Corn

Which is itself worth noticing. The weird technologies survive in niches exactly where their odd property is the property you need — humidity, noise, no moving parts — and nowhere else.



Herman

The RF condenser in the damp. The throat mic in the cockpit. The piezo on the bridge. Each one is the wrong microphone everywhere except one place.



Hilbert

It's a placement, not a species. That's the line you've been circling for twenty minutes, Herman.



Herman

It took twenty minutes? Felt like ten.



Hilbert

I want to agree with you about the conference thing, and I do, but you left out what the plate does to the room. In seventy-three I did the sound for a chambers in Truro — the county council had a table the length of a bus and microphones on stands, every one of them comb-filtering against the wood. I got permission to lay the elements flat against the tabletop, taped down, before anybody had a word for it. Solved the combing. Created a problem nobody billed me for.



Corn

Which was?



Hilbert

The table. Half an inch of veneered pine that size is the biggest diaphragm in the county. Every pencil, every teacup, every chair leg in contact with it came through louder than the man speaking. Aldous chaired every meeting and ran fifty-two minutes, every time. Fifty-two. I timed him for a year. His teaspoon was on my left channel like a percussion instrument.



Corn

So the surface stops being furniture and starts being part of the microphone. Fully.



Hilbert

That's the part the spec sheet doesn't mention. The manufacturer assumes a table. They don't tell you the table has opinions. And Corn — your line earlier, about the mic being only half the product. I've been looking at my own kitchen table differently since you said it.



Herman

What, you think it's listening?



Hilbert

It's a poor listener. Trays and cups, mostly.



Corn

Fifty-two minutes exactly, every time.



Hilbert

He died in eighty-eight. Still over.



Herman

The teaspoon on its own channel is the detail I'm keeping. Because it's the boundary mic's weak spot stated as a fact about a room — the same physics that gives you the free six decibels gives the teacup its free six decibels, and the teacup is closer to the wood than any talker ever is.



Corn

And it reframes the bass problem, too. We said the plate has to be big enough for the low frequencies — well, a big plate is big enough for every low frequency the room contains. The kick-drum application makes sudden sense. Nobody's conferencing with the kick drum; the floor in front of it is the surface.



Herman

The placement keeps escaping the job description, and the reason is that it was never a job description in the first place — it's a physical arrangement that pays off anywhere a large rigid surface and a source share a room.



Corn

So here is Daniel's map. Most of what gets called a rare microphone type is a placement, a pattern or a job, and the real mechanisms fit in a short list.



Herman

And the boundary-versus-conference confusion is the small case study: physics and product categories tangled together in ordinary language until two names for the same shelf in the shop sound like two theories of sound.