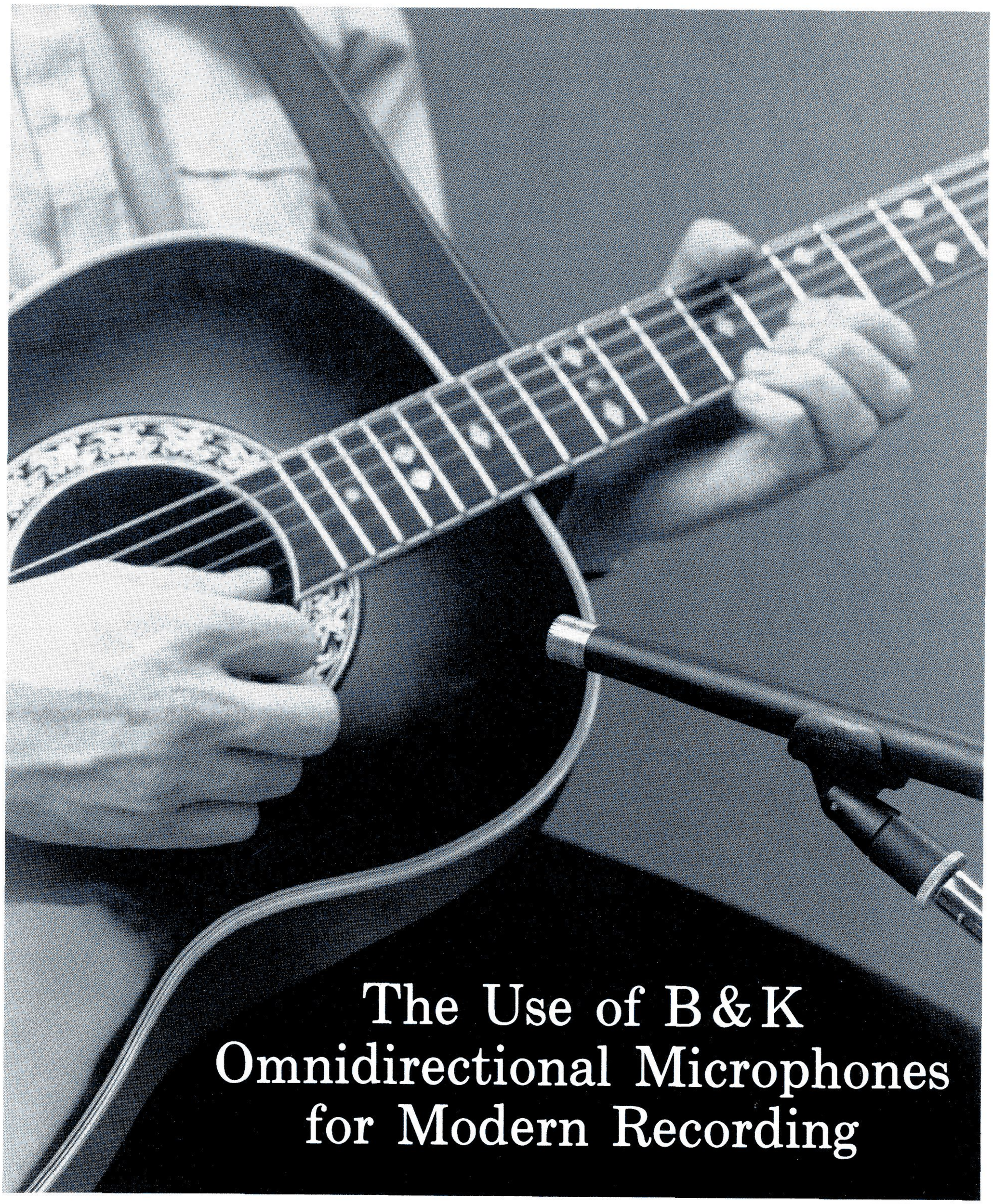
Brüel & Kjær application notes



The Use of B&K Omnidirectional Microphones for Modern Recording

BO 0101–12

The Use of B & K Omnidirectional Microphones for Modern Recording

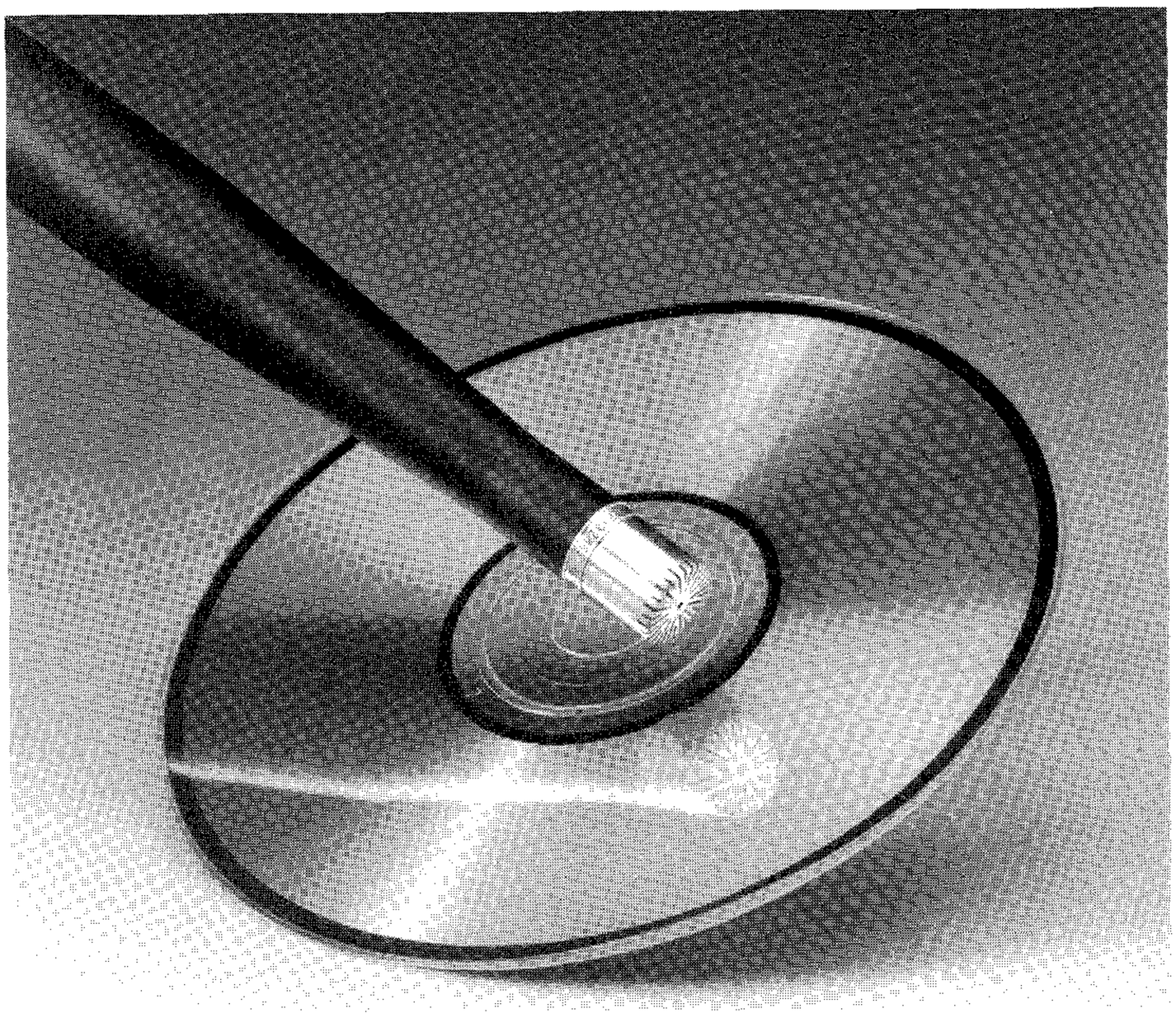
by David Rideau *

Introduction

Brüel & Kjær has long set the standard for precision measurement equipment within the fields of acoustics and vibration. And, if you have ever "voiced" a pair of control room monitors, there is a good chance you've already used a B & K omnidirectional microphone.

Prior to 1978 I had not seen a B & K microphone used for an actual recording session. It was then that I met an engineer by the name of Paul Grupp who had modified the pre-amp/power supply of a Type 4133 omnidirectional test microphone to make the noise level acceptable for recording purposes. The first application that I experienced was a lead-vocal "overdub". Never had I witnessed a mic that delivered such a clear, crisp vocal sound.

Since that time, I've used the 4133/4134's in many diverse recording situations, in the few studios in the world that had made the same discovery. It was only natural B & K realized



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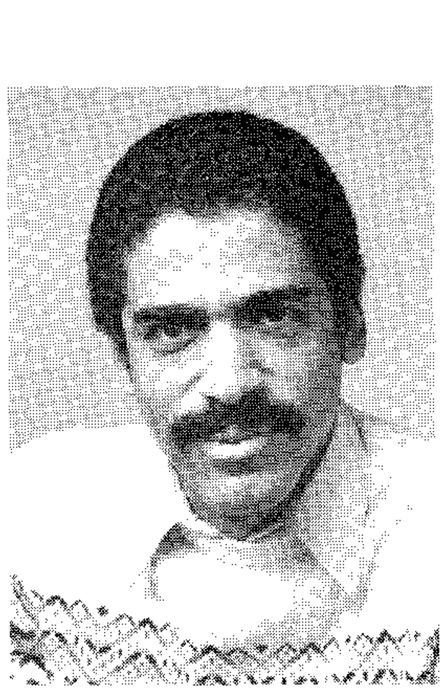
* *DAVID RIDEAU has been working as an engineer for eight years, recording sound for record and film both in the United States and in Europe. During this time he has also aided and advised in the construction of four recording studios, written for one of the recording industry's major periodicals and produced several record albums.*



Front Cover: A typical set-up using B&K Type 4003 omni for recording a steel-string acoustic guitar. The author places the microphone some 10 – 20in from the upper finger board and angled slightly towards the sound hole. Similar set-ups can be used for related instruments such as mandolin and classical gut- or nylon-string guitar

this potential, and developed the 4000 series of Studio Microphones. These mics have the same basic qualities of the 4133/4134: high power handling and excellent phase and frequency response, in conjunction with a design that guarantees a low inherent noise level. Phantom powered models are also now provided.

Studio microphone design is not only a logical evolutionary step for B&K to take, but its development has come at a perfect time with regard to the "state-of-the-art" of the recording world. With digital recording in full swing, improved analogue techniques, and the reintroduction of Direct-to-Disc recording, never has there been more need for an accurate microphone with an extended dynamic range.

In the next few pages I hope to introduce some different possibilities (through mic positioning) that could help you get the most from your B&K omni microphone. To suggest that these placements with regard to the respective musical instrument are the only possibilities is quite ludicrous. Sound and music both have very subjective qualities and few people can be in total agreement with others' impression of "sound", but the examples to be shown here have been tested and used with success by myself and other engineers. We hope you have the same or better success and are inspired to experiment with many other uses.

Applications

Vocals

Undoubtedly, the most popular application for the B&K omni microphone is the vocal. Once most singers hear the clarity the 4000 series provides, there is no turning back. Recording a "lead" with a B&K omni also has valuable "plusses", such as greater freedom of movement. With a "traditional" lead vocal set-up — large-diaphragm condenser mic set to the cardioid polar pattern — there can be irritating problems with regard to singer/microphone relationships. As the singer moves closer to the mic there is a build-up in the low frequency area (proximity effect). In addition, the physical presence of these usually large-sized mics causes reflections between the microphone and the singer's face. This results in changes in the in-situ frequency response of the mic. Generally the artist finds a distance that is most pleasing to the engineer-/producer, and maintains that distance throughout the performance or the sound quality can change drastically. The artist must also watch their "p's", since the mic is highly susceptible to vocal pops. In comparison, working with the 4000 series is almost care-free. I generally place the mic approximately 12 – 16 in (30 – 40 cm) directly in front of the artist's lips. In this position, with a respectable amount of in-line limiting, the singer has a great deal of freedom of movement in all directions. Types 4003 and 4006 in particular are inherently insensitive to vocal pops so they are a very good choice for this application.

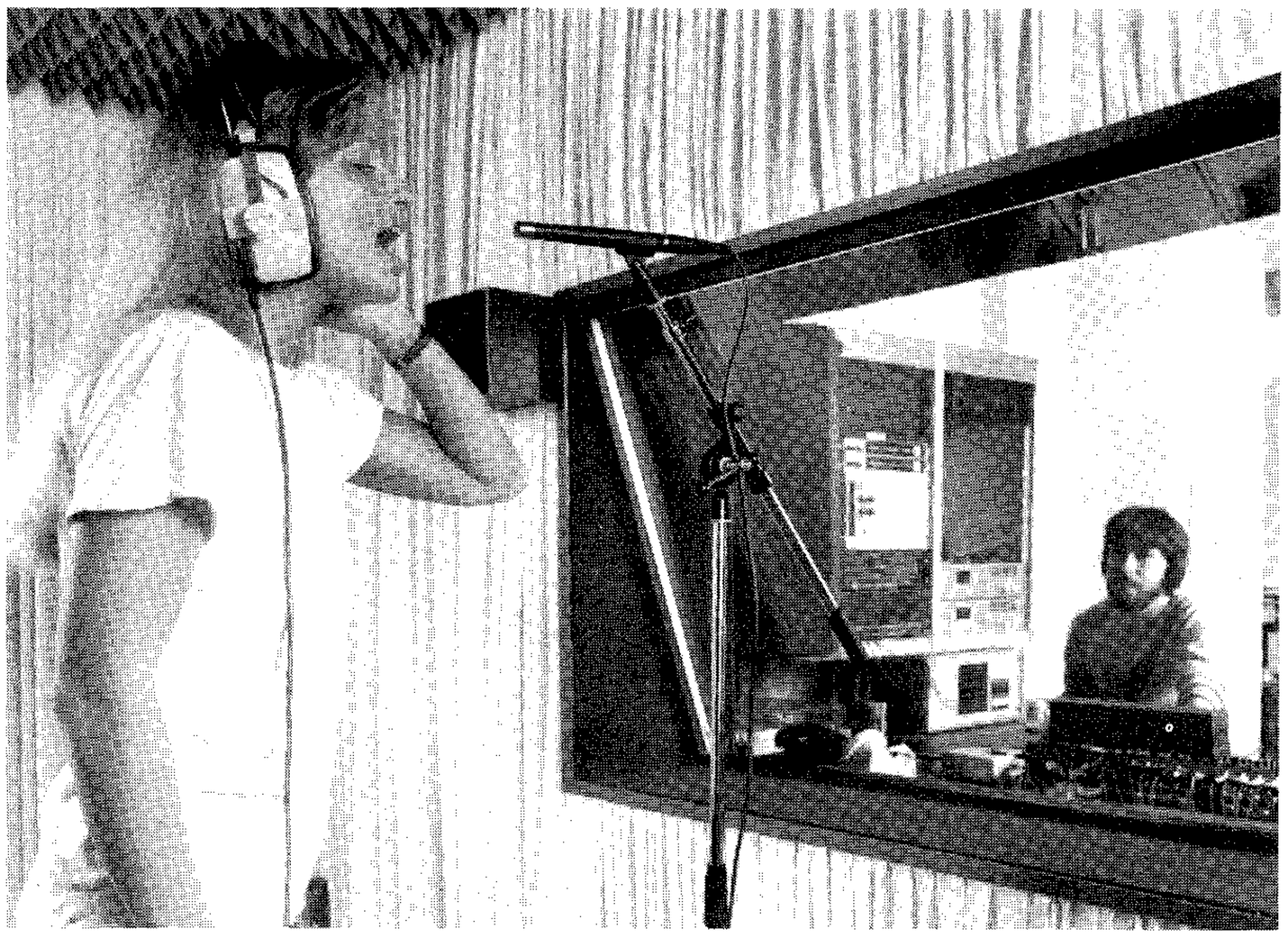


Fig. 1. The B&K omni mic provides a clarity on vocals that is hard to match using a traditional lead vocal set-up. Photo courtesy of Sound Track Studio, Copenhagen

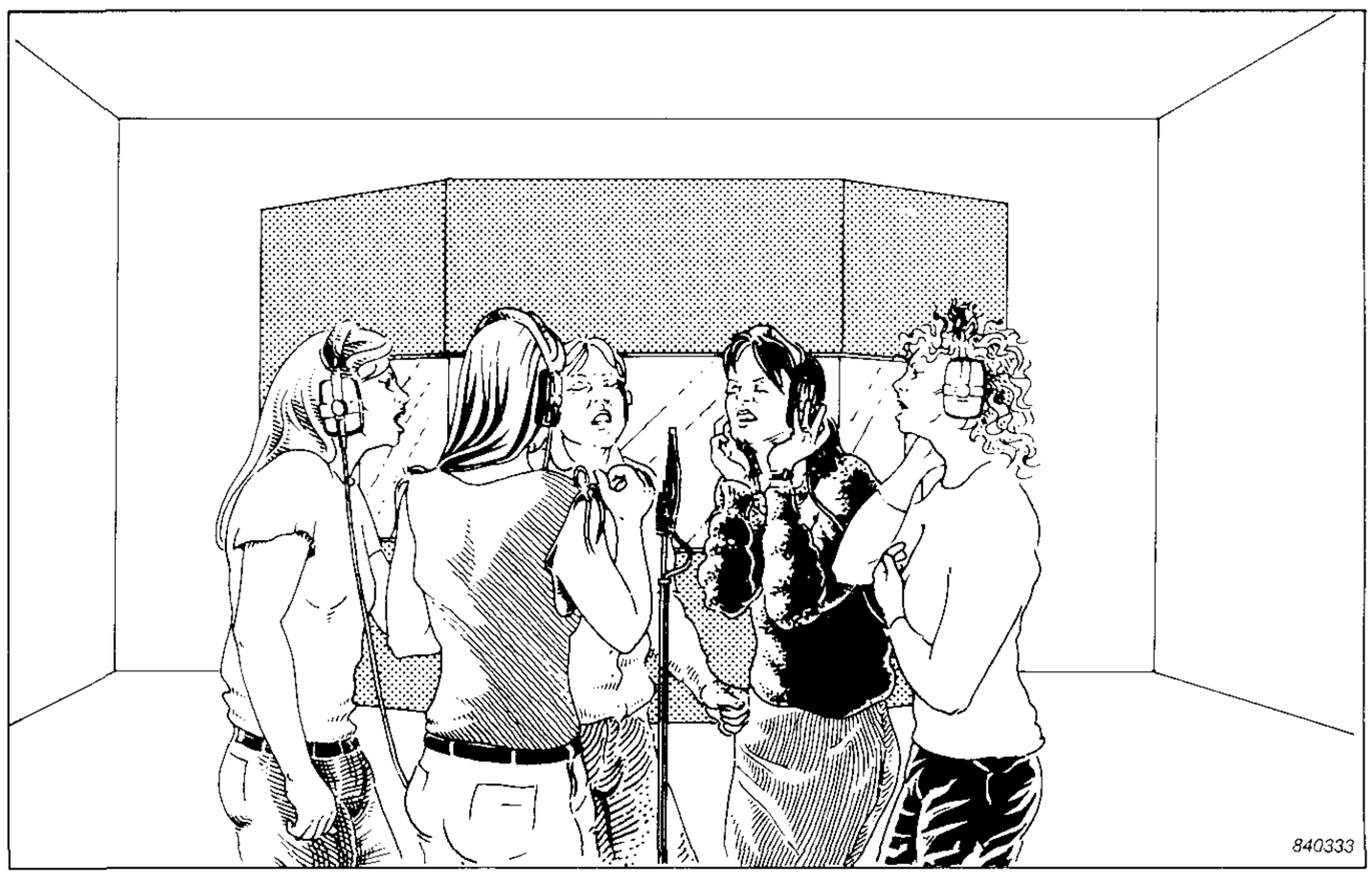


Fig. 2. A group of background vocalists encircling a B&K 4004 solves any problems about being on the "right side" of a mic's polar pattern

Problems can also occur when a cardioid/figure-of-eight polar pattern is used with a group of "background" singers; they must often crowd together to be on the "right side" of the microphone's polar pattern. A person

who is more to one "side" of the polar pattern often suffers in terms of frequency response and sensitivity.

For backgrounds I would recommend a 4004/4007 owing to its even higher degree of omnidirectivity. Place the mic pointing straight up towards the ceiling, the height of the capsule being just below the chin of the smallest singer. With this placement, regardless of whether there are two or twenty singers, vocalists can gather around the mic, positioning themselves comfortably with the only consideration being their personal output level relative to the distance to the microphone and to other vocalists.

Acoustic Piano

Acoustic Piano is another popular application of the B&K omni. This is probably due to the "colourless" quality of the mics over the entire frequency spectrum. Some engineers can't understand how one can create a stereo image utilizing omnidirectional mics. But as other engineers have proven, it is very possible and often beneficial.

Basically you're creating a stereo picture by the relationship of the distance between microphones with respect to the distance to the sound source. And it's very suprising just how little distance is needed between the microphones before a stereo "picture" appears. With the very wide, very flat frequency response and resulting fine time definition of the B&K mics, only small distances are required between mics to create a stable, well-defined stereo image.

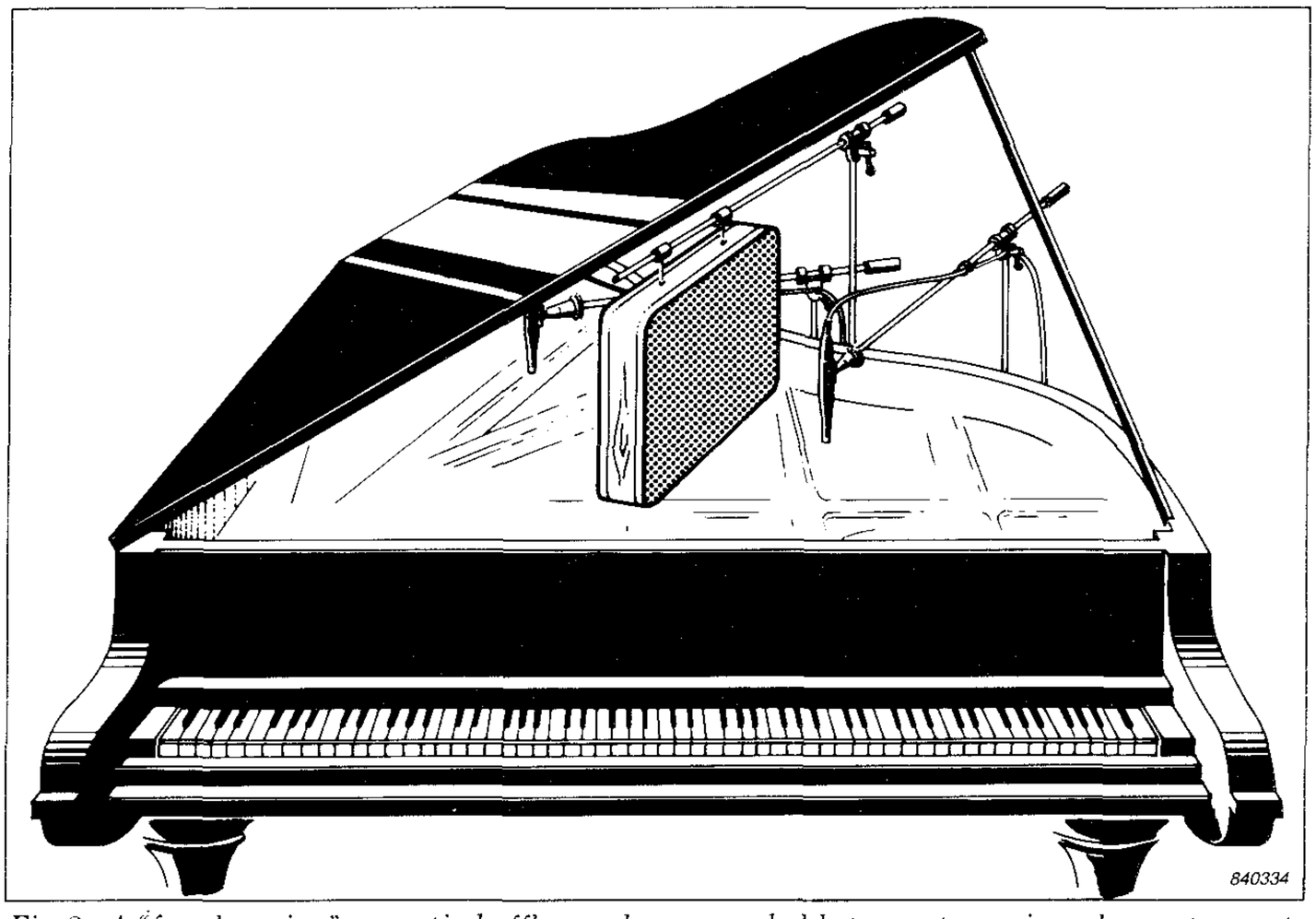


Fig. 3. A "free-hanging" acoustic baffle can be suspended between two microphones to create a more dramatic stereo effect

When I record a concert grand piano in an overdub situation, I generally place one omni 10 in (25 cm) directly above the hammers at about "High" C in relation to the keyboard. About 12 in (30 cm) towards the lower register of the keyboard and 10 in (25 cm) in from the hammers towards the end of the piano, I place the second mic. This pair alone creates a reasonable stereo picture, but for an even more dramatic stereo effect, I sometimes employ a "free hanging" baffle. The baffle consists of a 14 × 14 × 3 in (35 × 35 × 7,5 cm) block of wood with a 1 in (2,5 cm) layer of semi-rigid isolation (4½ pounds per cubic foot density) on each side. Hanging by string on a third mic stand, the baffle is placed between the mics. (I have seen or heard many variations of this theme, reminiscent of the Jecklin disc (for example, an oval-shaped baffle).) The result is a piano sound with great stereo imaging and equal power in every octave. Using the 4004/4007, subtle nuances are captured, while at the same time maintaining excellent headroom, with good high and low frequency transient response. Those low tones really benefit from the extended low-end of the B&K mics.

Percussion

The 4004/4007 model is ideal in the percussion overdub situation. In high frequency transient response it is unequalled. It can also handle a tremendous overall level where most other condenser mic capsules fail. Generally, when I record percussion such as tambourine, shaker, cowbell, and other small hand- held instruments, I have the musician stand somewhere between 30 – 60 in (75 – 150 cm) from the mic which is placed about chest level. Dynamics can vary wildly, so there is usually also a "fast" limiter in line.

For skinned instruments such as congas, bongos, african drums, e.t.c., I place the mic as close as possible, 10 – 20 in (25 – 50 cm), over the drum head without impairing the player's freedom of movement. This placement provides the "slap" that is frequently lost when recording these instruments. For glockenspiel, vibraphone, and marimba, you can also achieve a most faithful reproduction by using the same placement (10 – 20 in over the instrument). These instruments in particular utilize the "purity" and "brilliance" of the 4004/4007.

Fig. 4. Incorporating ambience in an overdub situation. The reverberation time (RT60) of the studio is 0,8 s at 500 Hz. Photo courtesy of Easy Sound Studio, Copenhagen

String Family

String instruments can benefit greatly from the accuracy of the B&K mics in a diffuse field. Almost always when a string instrument or section is miked, one should incorporate the natural ambience of the room being used. Often a large diaphragm condenser mic (even when set to the omnidirectional polar pattern) can project a "blurred" spatial image of the room's "reverberance". The diffuse field response of the smaller diameter B&K Types 4004/4007 is linear (± 2 dB) up to 11 kHz. Larger diameter, low-noise Types 4003/4006 are supplied with an additional protection grid which may be fitted in place of the standard grid to give a flat diffuse field response up to approximately 15 kHz.

For a normal "pop" string session which usually consists of 6 to 12 violins in "pairs" (with two players reading one set of music) I place a 4003/4006, with the special grid, pointing directly over the two musicians' chairs at a distance of about 5 – 7 ft (1,5 – 2 m) depending on the reverberation characteristics of the studio used. Violas are also miked in the same manner. With celli, I place the mic just over the bridge at a distance of 10 – 30 in (25 – 75 cm). This should produce that "resin" sound of bow movement that is often lacking in the recording of this instrument. Double bass is miked in the same manner.

Wind Instruments

Brass instruments with their wide dynamic range and sometimes brutal high-end transient, can be a problem to record. For trumpet, coronet, trombone, flügelhorn, e.t.c., the 4004/4007 does the job magnificently. Placed 6 –16 in (15 – 40 cm) from the "bell", these mics will reproduce every subtle detail of a musician's tone.

For saxes I place the 4003/4006 at about the same distance over the "bell" of the horn, but slightly favouring the "valve" side of the instrument. Through experimentation you can find a particular musician's "sweet" spot, which varies according to the player's personal style.

For clarinet, bass clarinet, flute e.t.c., I place the 4003/4006 6 – 16 in (15 – 40 cm) over the valve area, approximately in the middle of the instrument.

Please keep in mind that the previously mentioned wind and string instrument placements are recommended with the small-ensemble overdub situation in mind. In this setting, close-miking techniques are required to provide isolation between instruments so that the engineer/producer can control any imbalances that may exist in the studio. In a classical setting these balances between instruments or sections should occur naturally, demanding a more distant "overall" mic placement. But, even in the ensemble overdub situation, an overall mic can be essential in creating a natural blend of instruments. Try to place a "stereo pair" 12 – 16 in (30 – 40 cm) apart, just behind the conductor and 2 – 6 ft (0,6 – 1,8 m) above his head, depending on the size of the groups and the studio ceiling height. This signal blended with the individual mics often produces a very pleasing combination.

Fig. 5. Overdubbing sax and trumpet, with the mics. placed about 8 in (20 cm) from the bell. Photo courtesy of Easy Sound Studio, Copenhagen

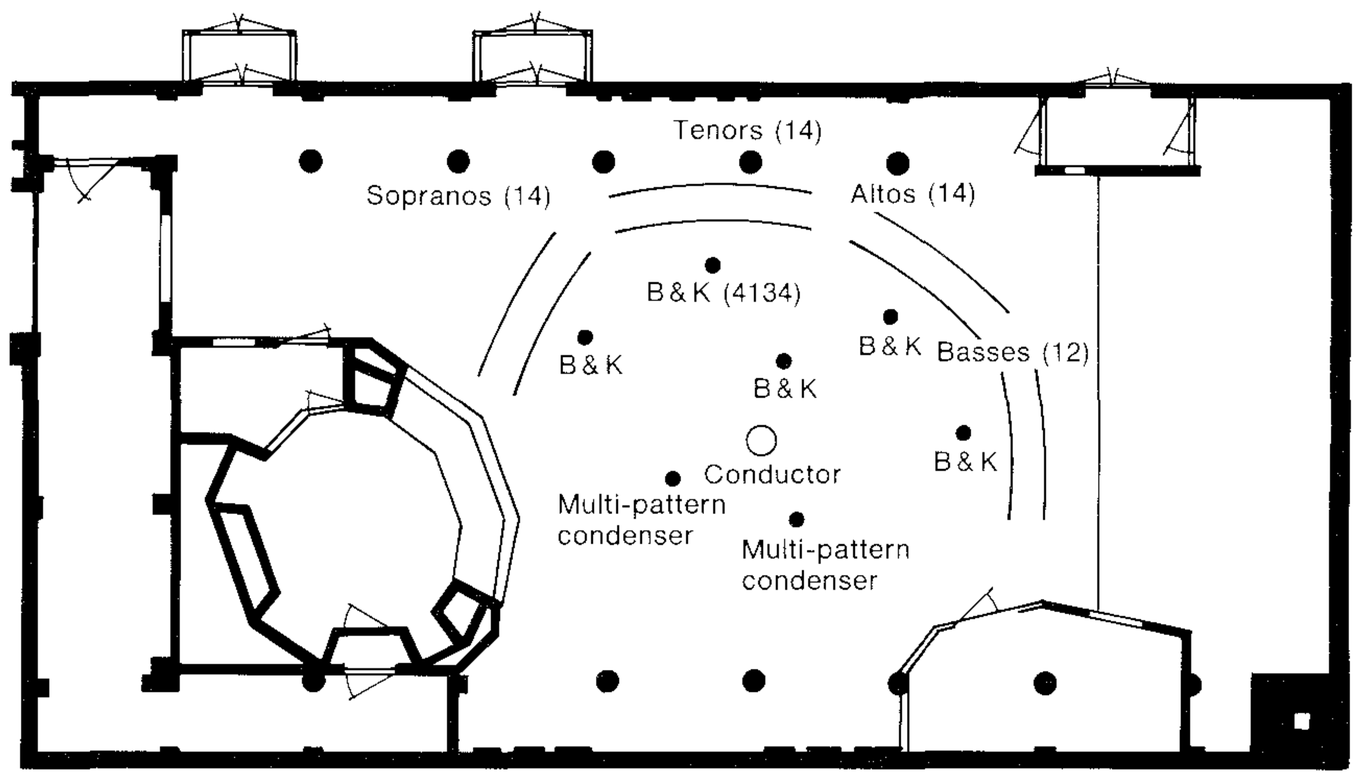


Fig. 6. Microphone positioning for a recording of the Royal Theatre Opera Company at Easy Sound Studio, Copenhagen, August 1981

Guitars

The "clarity" that can be achieved with the B&K omnidirectional on a steel-string acoustic guitar is hard to be beaten by other mics. With the mic placed 10 – 20 in (25 – 50 cm) in front of the upper finger board and angled slightly towards the sound hole, the artist enjoys the same freedom of movement as a lead vocalist. This same placement of the 4003/4006 of course applies to the other stringed instruments in the same family: classical guitar (nylon- or gut-string), mandolin, e.t.c.

Fig. 7. Guitars, mandolins and related instruments enjoy the clarity of a closely placed B&K mic.

On several occasions when I have used the B&K in this way, I have experienced "side-effects" in the form of a musician's fears. Never before have they heard their performance reproduced so perfectly. Every little detail which previously escaped unnoticed can now be heard. When this "perfection" proves to be undesirable, I place a large diaphragm condenser set to the cardioid polar pattern at approximately twice the distance from the instrument as the B&K mic. A combination of these two signals almost always provides a final product that both the musician and I can agree on.

For electric guitars I must admit to being partial to the "tight", "compact" sound a dynamic mic provides when placed directly in front of the speaker cabinet. This is due largely to its limited frequency response. But, I also place a 4003/4006 some 5 – 10 ft (1,5 – 3 m) in front of the cabinet. The addition of a small amount of this signal to the original signal can produce a nice "open" quality that is very hard to create electronically. For "heavy" rock guitar sounds, employing a larger cabinet, I will even add a third mic (4003/4006 with special grid) at an even greater distance if it's the "arena" type ambience the artist is looking for.

Electric-bass cabinets are another story. They genuinely appreciate the flat frequency response and headroom the 4004/4007 can provide. Place the mic directly in front of the loudspeaker at a distance of 6 – 12 in (15 – 30 cm), and limit to taste.

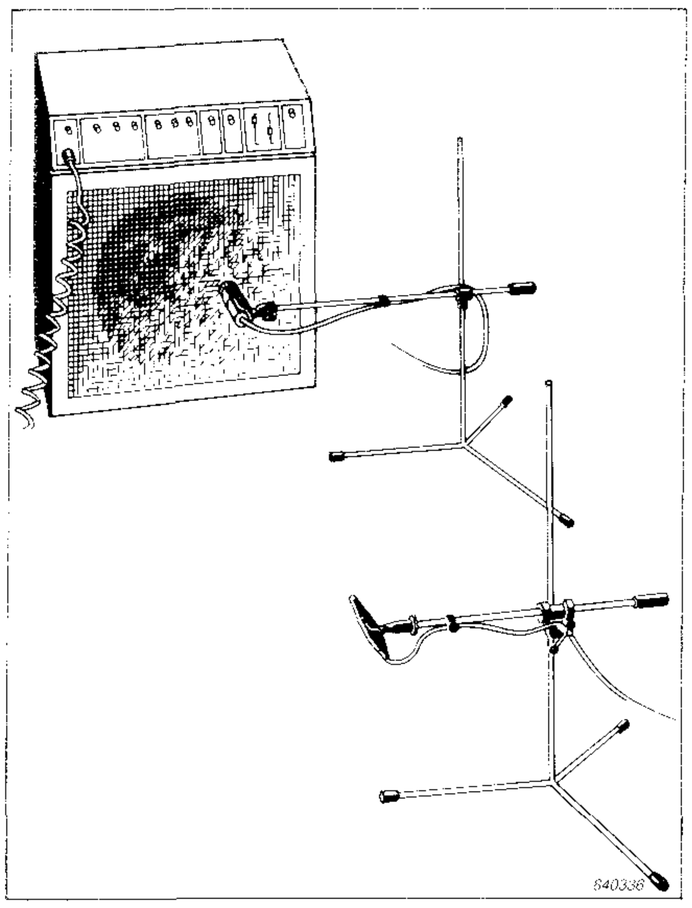


Fig. 8. For a more open sound when miking an electric guitar, a second mic such as the 4003/06 can be placed at some distance from the cabinet, and added to taste

Drums

The drum set in the modern studio is one of the most difficult challenges for a recording engineer. Often, one is required to create a "fantastic" sound, while at the same time maintaining isolation within the drum kit itself for later artistic control. This undoubtedly results in a microphone on every tom, or between every two toms (the latter more desirable being less prone to phase problems). Also there are separate mics on the snare drum, bass drum and high-hat, two overhead mics, and even one or two used as ambience mics. In this situation it is very hard to do the entire set-up with omnidirectional mics. I usually begin with large-diaphragm condenser mics set to the cardioid polar pattern and placed 3 – 6 in (7,5 – 15 cm) over each tom-tom, or one mic placed slightly higher between every two toms. In either case the diaphragm is positioned over the rim of the tom, towards the front of the set. For the snare I usually use a dynamic mic to aid in isolation from the high-hat. The 4004/4007 can be used in many instances for the bass drum, providing a "crisp" and "clean" kick sound. Placement can be very different depending on the drum, but I like the front head "off" with the mic placed inside the drum, slightly off-center and 10 – 20 in (25 – 50 cm) from the back head. Be prepared to use some type of cover or enclosure for the bass drum itself in case more isolation from the rest of the set is needed. I

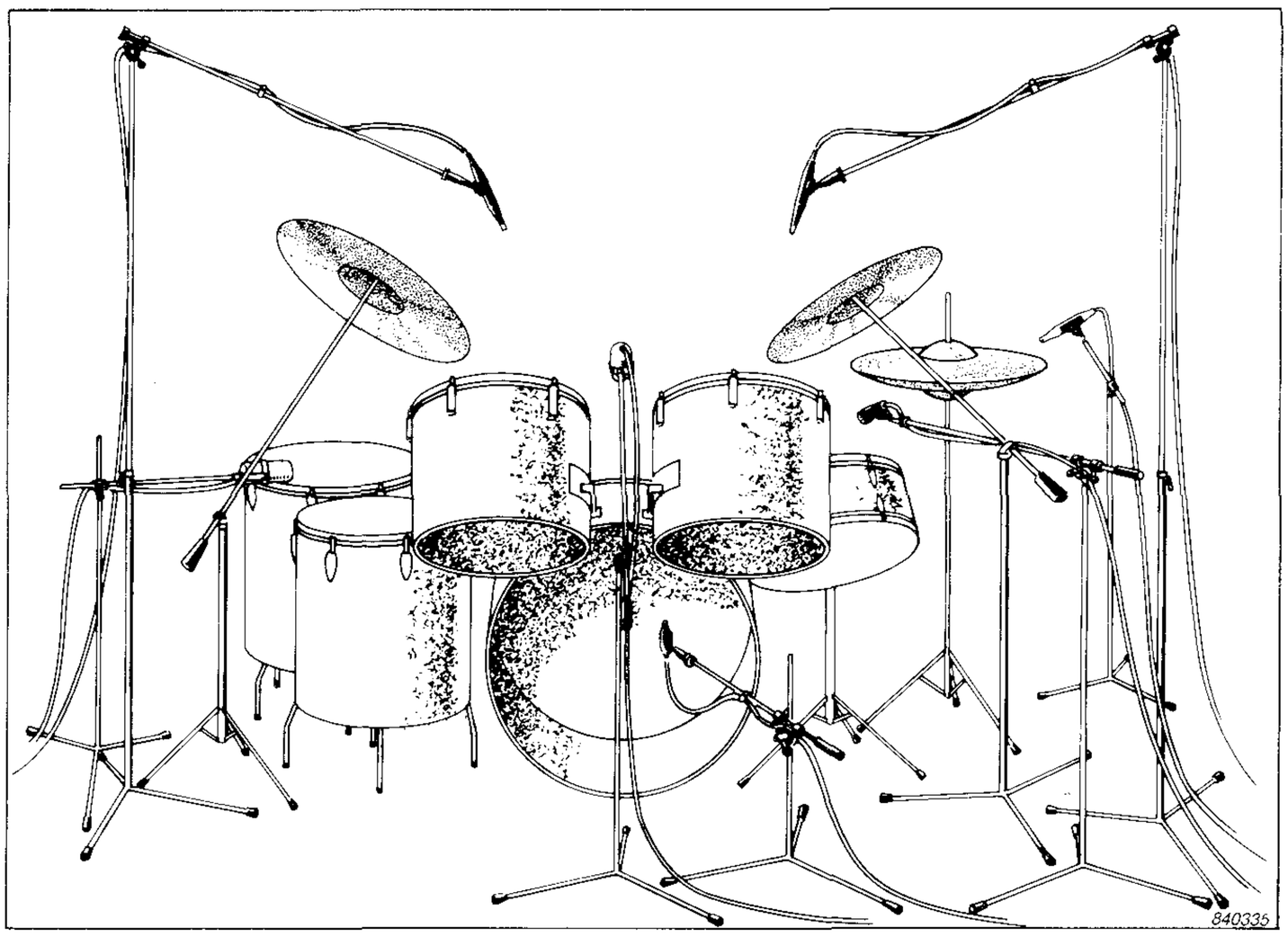


Fig. 9. The modern drum sound can prove quite a challenge with many varied mics being used to attain the overall sound an artist or producer is seeking. Here, a 4004/07 is placed, slightly off-centre, inside the kick-drum to provide a clean, crisp sound. An overhead pair of 4004/07's proves pleasing, giving cymbals a transparent quality and a finely-tuned stereo image of the complete drum kit

generally use some sort of isolation anyway, even when using a cardioid pattern mic.

The overhead mic position is where the B&K mic can really shine, giving cymbals that "transparent" quality. Place 4004/4007's on either side of the kit just outside the drummer's shoulders and 12 in (30 cm) or more over his head. Experiment with the "fine-tuning" until you achieve a good stereo picture of the set (mics placed Left/Right in the monitors), at the same time checking coverage of cymbals. You can then mix in the individual tom-tom mics as needed, if needed at all!

Everyone is aware that the more mics you use for a particular instrument, the greater the chances are that phase atrocities will occur. What the B&K omnis as overheads can often provide, is a better overall picture where individual mics are less essential to the final product. I remember one of the best drum sounds I've experienced was a session a fellow engineer and I had agreed to do for a group that needed a quick, "very rough" demo-tape. With this in mind we did a quick, "very rough" set-up that consisted of, among other things, dynamic mics on bass and snare drum with a single B&K omni mic over the drummer's head. The clarity and transparency of the toms and cymbals were quite impressive! Alas, it's a stereo world ...but how much of our sound should we compromise?

Special Applications and Considerations

Speech and Effects

Because of the realistic accuracy of the B&K omni I have found it to be a prime choice for recording speech and special effects. In the course of recording for several films and many albums I've recorded breaking glass, firecrackers, footsteps, e.t.c., all with wonderful results. As an introduction to its merits in these respects I suggest having someone light a match when you have the mic set at a level for normal speech. I think you'll see what I mean!

"Good" Leakage

"Leakage" in the recording world has become a bad word. Most of the time engineers will go to great lengths to hold the levels as low as possible in order to avoid instruments "leaking" into microphones that were not intended for them. In general this approach is the quite correct, but in certain special conditions, leakage can be used advantageously. For instance, I once recorded a jazz singer whose group consisted of drums, sax, piano, and upright bass. The singer/group-leader could understand why I had to use a "drum booth" to keep this instrument from "spilling" into all the other mics, but couldn't understand why she and the other band-members couldn't gather "cozily" around the open concert-grand piano.

I finally agreed to the idea and subsequently used B&K omnis on the piano, sax, and vocal, after unsuccessfully trying several other directional mics. I placed several "gobos" in strategic areas, but no one was deprived of direct eye contract. I then proceeded to bring up the faders and was surprised that the leakage situation was not as bad as I had anticipated. Mixing afterwards was a "breeze", simply bringing up the faders until I heard a reasonable balance between all the members, and that was that. Other than a few subtle moves for solos and more difficult vocal passages, the mix basically took care of itself!

Of course there was leakage between all the instruments and microphones, but instead of the "boxy" unusable leakage we are too used to hearing, it was a pleasant leakage that could easily blend with the other signals, producing a minimum of phase colouration. Naturally in these cases, positioning is critical (I used the theory of equal or even multiple distances between all the various mics: the piano mics were 20 in (50 cm) from each other, the vocal mic 40 in (1 m) from the high piano mic, the sax mic 40 in (1 m) from the vocal mic, e.t.c.) but a little experimentation can bring rewarding results.

Diffuse Fields

Owing to the excellent phase response at all angles of incidence, the B&K omni is an excellent choice for an ambience mic. With the close-to-ideal amplitude and phase responses and corresponding faithful rendition of reflections, the B&K omni creates an accurate acoustic snapshot of the room. Try it in conjuction with drums, electric guitar, e.t.c. It can also be used effectively as a mic in a live chamber. The best suggestion I can make here is to avoid the extreme corners of the enclosure where low-end build-up usually occurs, and simply use your ears.

Line Level System

There is also a transformerless microphone power supply (Type 2812) that is available for use with the 4003 (low-noise) and 4004 (high-intensity) mics. The possibility to bypass the microphone pre-amps and phantom power on a particular console can often mean great gains with regard to phase and distortion performances, especially in the low frequency areas. With the 2812 you can use the line input on the console or even route directly to a channel of your tape deck. The latter can be a most effective part of a live stereo set-up where the final product is only limited by your storage capabilities. In classical applications, with a properly balanced orchestra/ensemble in an auditorium or church with reasonable acoustics, the result can be astounding. I've heard digital recordings made in this manner which were very satisfying.

Adding Dimension to your "Track"

Omnis in the overdub situation can be a great tool. Many recordings made today can be forced into having a "one dimensional" image. Instruments are almost always "close miked" (usually cardioid polar pattern) in a studio that often is constructed to have a "dead" quality (short reverberation time). Without the aid of artificial reverberation and other effects, this makes for a very "one-dimensional" sound. The creative use of the omni mic during the overdub stages can often be used to place an instrument in its own "space" through the use of natural ambience. This can be a big help in realizing that second and third dimension engineers try to synthesize in the mixing stages of a production.

Omni versus Directional Microphones

Most of the previously mentioned set-ups are intended for the "overdub" situation. But, I still contend that with the judicious use of isolation rooms, gobos (portable acoustic barriers), piano covers, and other conventional isolators, the omnidirectional mic can be used in many situations. In general, mic placement should be closer than usual, whenever possible without a compromise of sound quality (an omni has the same isolation characteristics at 1 m that a cardioid would have at 1,7 m from the same sound source).

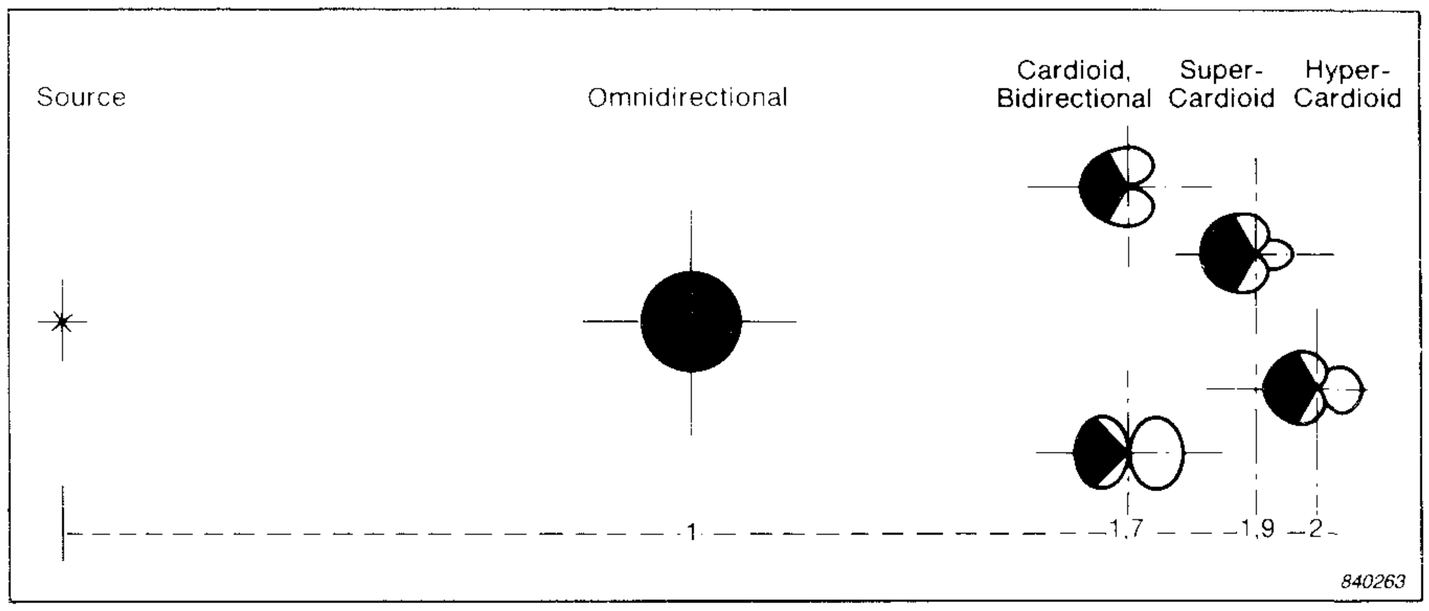


Fig. 10. Relative positions of various microphone types for the same amount of isolation (ratio of direct-to-reverberant sound)

"Tube" Type Condenser versus the B&K Omni

When asked to describe the way a B&K mic performs, my only comparison could be to the large and small diaphragm "tube" type condenser microphones of yesteryear, that are currently having a resurgence of popularity. I was lucky to be introduced to this type of mic in my career by an "old master" who realized something was lost through the incorporation of transistors into the condenser mic design. The B&K omni and the "tube" type microphones are similar in many ways, both producing a very "clear", "open" sound with excellent transient response. The main advantages the B&K omni has over the "tube" are inherent noise level, level handling capability, and dependability — three very important points for the engineer to consider when setting-up for a session.

Will Not Lie For You

B&K omnis are precision instruments. They will not lie for you. If you are a good singer, you will sound like a good singer. If you have an inexpensive guitar that rattles, you will have the same rattle on tape unless you can remove it electronically. The same can be said of the studio environment. If there is excessive background noise (traffic, air-conditioning, or even a squeeky chair) the B&K will let you know the moment the mic is switched on. But these factors should not be a problem in a well-constructed, well-equipped professional studio.

Conclusion

The B & K 4000 series are very accurate with an excellent dynamic range and "colourless" transient response. The fact that they are omnidirectional should not exclude them from an engineers "arsenal" of recording hardware. On the contrary, they can and should be incorporated into our ever-growing pool of electronic resources.

Once you experience their sound, it could even influence some of your basic ideas about recording. I know it has influenced me into often taking a more "classical" approach to mic placement in the modern overdub situation, finding that point where the balance between direct and reverberant sound is optimal with regard to the "basic" track.

Of course there will always be conditions where a directional mic must be used, but don't be afraid to experiment with your B & K mic when you have the opportunity. You could be very pleased with the results as I, and many other engineers, have been.

B&K Omnis

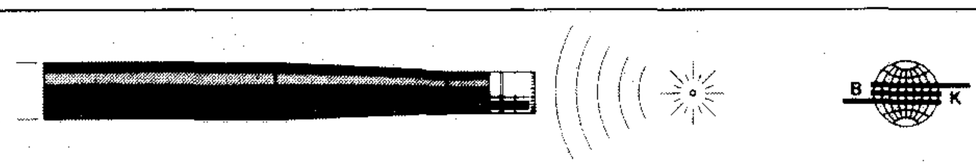
Microphone Type	4003	4006	4004	4007
On-axis Frequency Response (±2 dB)	20 Hz to 20 kHz		20 Hz to 40 kHz	
Sensitivity (mV/Pa)	50	12,5	10	2,5
Dynamic Range* (dB)	17 to 135		26 to 148	
Maximum Level (dB peak)	154	143	168	155
Powering	Type 2812	P48 Phantom	Type 2812	P48 Phantom
Dimensions** (mm)	⌀16 × 165		⌀12 × 165	

Selection Features	Low Noise Microphones:	High Intensity Microphones:
	■ 17 dB(A) noise floor guaranteed ■ "Warm" room sound ■ Extra protection grid for flat frequency response in reverberant field (ambience miking)	■ <1% distortion guaranteed at 148 dB ■ Extended high-frequency amplitude & phase responses ■ Superior transient reproduction ■ Minimal off-axis colouration
Direct Powering with 2812: ■ Transformerless signal path ■ High-level output: direct connection to any recorder ■ Increased headroom ■ Extended low-frequency response ■ Balanced or unbalanced output	**4003 & 2812**	**4004 & 2812**
Standard P48 Phantom Powering: ■ Direct connection to phantom power on consoles and recorders ■ Longs cables from microphone possible ■ No special power supply needed ■ Flexibility	**4006**	**4007**

* From A-weighted noise floor to 1% Total Harmonic Distortion. Types 4006, 4007: f > 100 Hz

** excluding connector

Calibration Chart for Studio Microphone



Type: 4003 **Serial no.:** 1084789

Low Noise, Omnidirectional Microphone

130 Volt Preamplifier power, B&K Type 2812

Calibration Data

Frequency Range: 10 Hz to 20 kHz ±2 dB

Sensitivity (at 250 Hz): 42,0 mV/Pa

Polarity: + V at pin 4 for positive sound pressure

Equivalent Noise Level: 16 dB(A) re. 20 μPa

Dynamic Range: >120 dB

≤ 1% THD at 135 dB re. 20 μPa

≤ 1% Diff. Freq. Distortion at 135 dB re. 20 μPa

Calibration Conditions

Barometric Pressure: 1006 mbar

Ambient Temperature: 24 °C

Relative Humidity: 56 %

Date: 06.09.1983

Signature: H.P.

1 Pa = 1 N/m² = 10 dynes/cm² = 10 μbar ~ 94 dB SPL (re 20 μPa)

Summarized Specifications

Microphone Cartridge

Outside Diameter: 16 mm with protection grid

Cartridge Capacitance: 13 pF

Polarization: Prepolarized backplate

Lower Limiting Frequency (–3 dB): 3 to 5 Hz

Handling Noise & Mechanical Vibration:

1 m/s² induces 64 dB re. 20 μPa equiv. SPL

Influence of Magnetic Fields:

80 A/m induces 45 dB re. 20 μPa equiv. SPL

Temperature Coefficient:

–0,025 dB/°C (25 °C, 1013 mbar, 250 Hz)

Influence of Static Pressure:

–0,002 dB/mbar (at 250 Hz)

Preamplifier

Input Impedance: >5,5 GΩ‖2 pF

Output Impedance: <30 Ω

Frequency Response:

4003/4: 20 Hz to 50 kHz ±0,2 dB
5 Hz to 150 kHz ±3 dB

4006/7: 20 Hz to 40 kHz ±1 dB

Inherent Noise (A-weighted):

4003/4: <2,5 μV

4006/7: <0,6 μV

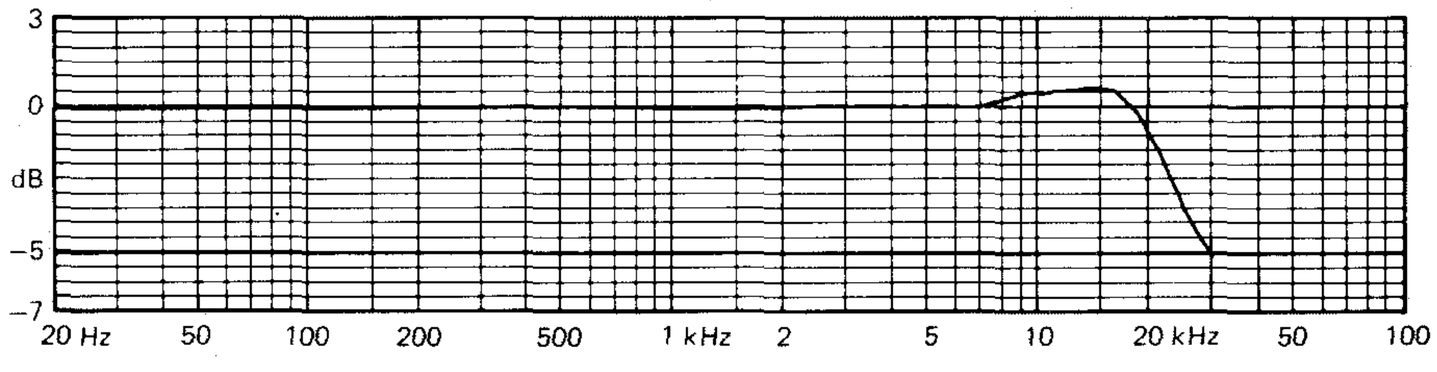
Powering:

4003/4: B & K Power Supply Type 2812

4006/7: 48 V Phantom Powering

Outside Diameter: 19 mm

On-axis free field response



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Brüel & Kjær

Brüel & Kjær
DK-2850 NÆRUM, DENMARK
Telephone: + 45 2 80 05 00
TELEX: 37316 bruka dk

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