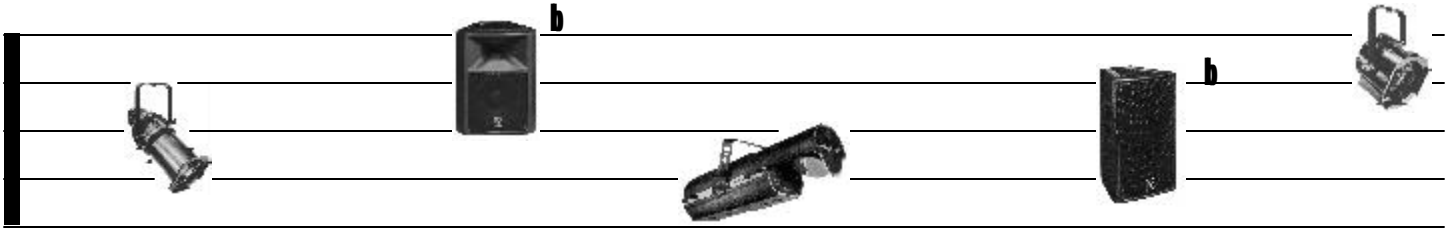


Jack A. Frost Ltd.

# STAGE NOTES



Jack A. Frost Ltd.

Volume 1, Issue 2

Supply and Rental of Power, Lighting, Sound and Staging Equipment

## In This Issue

**Mysteries of the  
Microphone Revealed**

**New at NAMM**

**Frost Goes Online**

**Microphone Sale**

## Mysteries of the Microphone Revealed

A Microphone takes sound and converts it into electrical signals that can then be manipulated and amplified by a variety of electronic devices. It was the invention of this device that made the telephone and the entire world of electronic sound systems possible. Before this, the manipulation of sound had been strictly a matter of the acoustical treatment of performance spaces. There had also been the occasional use of devices like the small speaking trumpets built into the mouths of masks in the Greek classical theatre.

Before examining how microphones work, we need to take a brief look at the raw material that they work with: **sound waves**.

Sound travels through the air in pressure waves which radiate at a fairly constant speed from the source of the original vibration which produces the sound. Each wave consists first of a region of higher air pressure, in which the molecules in the air

are forced together. This region is then immediately followed by a compensating region of lower air pressure, in which the air molecules are spread further apart. Two regions of alternating **compression** and **rarefaction** combine to produce one sound wave.

While the fields of audio engineering and acoustics have generated enough obtuse terminology to baffle all but the most determined audiophiles, sound waves have just two basic properties from which all the other jargon is derived: **Intensity** and **Frequency**.

### Intensity

The more energy in the sound wave, the greater the difference in pressure produced between the regions of compression and rarefaction. The greater the pressure difference in a sound wave, the greater the motion produced on the membrane of the ear drum, and the louder the sound. This difference in pressure is referred to as the **amplitude** of the sound wave, and is perceived as **loudness**. The unit of measurement of amplitude was named after Alexander Graham Bell. It was soon found to be too coarse to be useful, so it was divided into tenths, hence the **decibel**. This term is commonly abbreviated - even in speech - as **dB**.

### Frequency

Different sound sources will produce sound waves at a different rate. The **frequency** of a sound is the number of waves - or cycles - produced per second. Our brain perceives frequency as musical **pitch**: the higher the frequency, the higher the pitch. Frequency is sometimes referred to in terms of cycles per second, but this unit is commonly referred to as **hertz** (named

after a German physicist, not a car rental agency). For example, the fundamental note sent out when an orchestra tunes to an 'A' is vibrating at 440 cycles per second, or 440 hertz. Raising the pitch by an octave doubles its frequency, so one octave higher, 'A' becomes 880 Hz, then 1760 Hz, then 3520 Hz, etc.

In real life, however, most sounds are a complex mixture of many frequencies. A concert 'A' will sound very different when produced by an oboe, a violin, or a soprano. Beyond the **fundamental** note of 440 Hz, there are many multiples of that note - or **harmonics** - which are produced. Each instrument has its own particular blend of harmonics at different ratios: this blend of frequencies gives each instrument - or singing voice - its own unique **timbre**. Human speech is even more complex than music, since it is more irregular.

The human ear can perceive sounds in the general range between 20 to 20,000 Hz. The upper range generally deteriorates somewhat as we get older - particularly if we abuse our hearing. Most musical fundamental notes are in the lower part of this range. The highest note on a piano is just over 4,000 Hz; among singers, only the soprano can produce vowel sounds above 1,000 Hz. But the harmonics of these notes will quickly exceed our range of perception. In speech, vowel sounds occupy the lower part of the register, but consonants - particularly the sibilant "s" and plosive "t" - inhabit the higher frequencies of our hearing range.

Each piece of sound equipment deals with sounds of different frequencies in a different way, and this **frequency response** is one of the indicators of the quality of any piece of sound equipment, including the microphone.

## What a Microphone Does

Very simply, a microphone intercepts sound waves, and produces an analogue electrical current of the same **frequency** and relative **intensity**. A sound wave of 440 Hz will produce an electric current which oscillates at a frequency of 440 Hz. Changes in intensity of the sound are translated into changes in the intensity - or voltage - of the current, (**dB** refers to voltage when sound signals are being discussed). Once a sound has been converted into an electrical signal, it can easily be mixed with other sounds, modified by a variety of electronic

devices, or stored on a cassette or reel-to-reel tape deck. It can also be converted to digital format, and stored on a DAT, a CD or on a computer's hard disk. Ultimately, this signal is amplified and passed on to a speaker, a device which converts an electrical current back into sound pressure waves of the same frequency and relative intensity

## How Microphones Work

Like the human ear, all microphones have some form of **diaphragm**, which is - just like the eardrum - a sensitive membrane which moves in response to sound pressure waves. A microphone uses one of the five following methods to translate the movement of this diaphragm into an electrical current.

A **carbon microphone** is a container of carbon granules through which a small electric current is passed. The diaphragm is placed over the top of this container. As the sound waves force the diaphragm in and out, it compresses the carbon granules at the same frequency as the sound waves, thereby varying the resistance of the carbon to the electric current. The varying resistance results in a voltage change which matches

the vibration of the sound waves. Carbon mics are very cheap to make, but very crude, and were the microphones used in telephones and uncomfortable "operator-style" headsets for many decades.



Figure 1

A **crystal microphone** relies upon the piezo-electric effect, in which certain types of crystal produce a small pulse of electricity when they are bent. A thin wafer of crystal is the diaphragm, with two electrical leads attached to the edges of the crystal. This type of unit was popular in cheap cassette recorders two or three decades ago. Like the carbon microphone, it has largely

fallen out of favour because of its poor quality, and has been replaced in cassette recorders by the inexpensive but vastly superior condenser microphone.

The **moving coil dynamic microphone** is the workhorse mic of the entertainment industry, and is usually referred to simply as a **dynamic mic** (Figure 1). At the head of the microphone is a sensitive diaphragm which moves in response to sound waves. Attached to this diaphragm is a small voice coil, with leads from the coil providing the signal output from the mic. As the diaphragm is moved back and forth by the sound waves, the coil is moved past a small magnet which passes in and around the coil, but which does not touch it. This movement of the coil through the magnetic field creates an electric current which varies with the movement of the diaphragm.

The current produced by a dynamic mic is quite small, in some cases as little as a millionth of a watt! The relatively small weight of the coil attached to the diaphragm is still enough to limit its ability to respond to very high frequencies, and the frequency response of a dynamic mic does not usually exceed 16,000 Hz. Nevertheless, that sort of response is more than adequate for most situations. The basic design of this mic also allows for very rugged construction, and dynamic mics have been known to take a lot of abuse and still perform.

For years, one well-known mic was demonstrated as being so tough that one could hammer nails with it. While ruggedness is a useful characteristic, there are more appropriate tools for carpentry - and not even the best claw hammer in the market is supplied with audio specifications. Don't let anyone try this at home - or in your theatre.

The **ribbon microphone** works in a similar fashion to the dynamic mic. The ribbon mic gets its name from a delicate metal ribbon which is held between - but not touching - two magnets. The sound waves vibrate the ribbon in the magnetic field, and the current induced in the ribbon is carried by leads attached to each end. These mics are wonderfully sensitive and responsive, exceeding the performance of dynamic mics. By nature, however, they are large, fragile and expensive, so their use is usually confined to the controlled environments of radio broadcast and recording studios. If you have one of these gems, keep a close eye on it, and don't let the local basement grunge band within a mile of it.

The other type of microphone that one will usually encounter is the **condenser microphone** (Figure 2). "Condenser" is the British term for the basic electronic device which we call a **capacitor** in North America. A capacitor has two electrically-conductive plates with wire leads attached to them. These two plates are separated by a material called a dielectric. When an electrical charge is fed to a capacitor, it will let that charge build up to a certain point, and then it will instantly release the charge.

One of the factors determining how much of a charge can be built up before release is the distance between the two plates.

In the condenser mic, one of the plates of the capacitor becomes the actual diaphragm of the microphone. A constant charge is fed to the plates from a battery or power supply. As the diaphragm plate moves with the sound waves, the voltage of the current discharged varies constantly with the sound vibrations, and this current is carried out the wires from the capacitor.

Condenser microphones can offer a remarkable frequency response - often exceeding the range of human hearing. They can also be made very cheaply and still offer acceptable performance, and are the type you will find built into the cases of many cassette recorders. They can also be made very small: a high-quality condenser mic

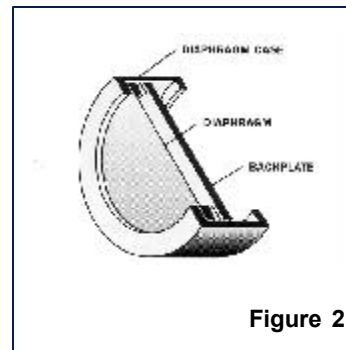


Figure 2

### Stage Notes

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element can be less than 1 cm across. For this reason they are the inconspicuous hairline and lapel micro-phones used in radio mic systems, and the tie-pin mics favoured by newscasters.

### Pick-up Patterns

No, this has not turned into a discussion of human mating behaviour. The title of this section refers to the directional characteristics of different

microphones; their ability to "pick up" sounds at various distances and directions. Both dynamic and condenser mics can be made to conform to various patterns. The pick-up pattern of a mic does not depend on the mic element itself, but upon the construction of the mic housing, including the support of the mic element, and the various baffles which control how the sound waves interact with the mic element, and with each other.

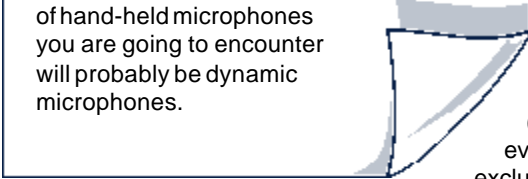
An **omnidirectional microphone**, as its name suggests, responds equally well to sound from all directions (*Figure 3*). While this is very useful for broadcasting a radio play, or recording sound effects in a controlled environment, it can play havoc in most live performance situations. First, it picks up not only the performers you want to hear, but every other sound in the room. Second, if that sound is being fed to a loudspeaker, the amplified sound will find its way back

into the mic, back through the system, out through the speaker, and so on, getting louder on each trip. This instantly produces that teeth-grating ringing known as **feedback**. Leave it in the studio and keep it off the stage.

A **cardioid microphone** is more directional. It is most responsive to sound directly in front of it, and gradually becomes less responsive as the sound source moves around to the side (*Figure 4*). This heart-shaped pattern is the reason for the term

## Which Type of Microphone Do You Have?

A microphone found in a live performance situation will usually be either a dynamic or a condenser mic. Miniature mic elements can be assumed to be condensers. Apart from that, dynamic and condenser mics can perform the same function, and be very similar in appearance. If you are not sure which type you are dealing with, see if it uses a battery in the body of the mic, or a power supply unit, or see if it requires the "phantom power" switch to be turned on at your sound mixing board. If it does require a power supply of some sort, it is a condenser mic; if not, it is a dynamic mic. The majority of hand-held microphones you are going to encounter will probably be dynamic microphones.



and avoiding feedback

For vocal use, a cardioid or hypercardioid mic is most effective when held 10 to 20 cm directly in front of the mouth, on an axis that runs down the centre of the mic. If your sound source is moved to the side of this axis (e.g. if the speaker tries to talk into the side of the mic) you may still hear quite a bit of the sound, but the quality of the sound will change. This happens because directional microphones do not

react to all frequencies in the same manner, and the highest frequencies fade away most quickly as you move away from the centre-line axis. This "off-axis colouration" can subtly compromise the quality of the sound if the performers or sound people aren't aware of this characteristic of directional microphones.

Each microphone does, in fact, "colour" the sound it picks up to some degree, even when it is used correctly. Each microphone will introduce some particular characteristics in the way it picks up some frequencies better than others, and in the way its pick-up pattern varies from one frequency to another. This makes

"cardioid", which has as its root the latin word for "heart".

Cardioid mics are commonly used in live performance situations, since they can be used to pick up individual performers or instruments in a noisy environment, and are resistant to feedback.

A **hypercardioid microphone** has an even narrower pickup pattern, and is popular for use with acoustic musical instruments (*Figure 5*). They are even more effective at

different tasks. The mic that does a wonderful job of picking up a stand-up bass may not be so well-suited to catching the warblings of a "breathy" soprano.

Nevertheless, unless one is in a very well-funded facility, one does not usually have the luxury of a stable of specialized microphones. A good job can still be done with one or two models of good-quality, general-purpose mics. Each type of microphone has its own "voice": better microphones will usually have better voices. A preference for one microphone over another is a very personal thing, and one's ears are more important than a list of electronic data in establishing that preference.

### In the Next Issue...

The cardioid and hypercardioid microphones discussed in this issue are meant to be placed within inches of the sound source, or held a few inches from the mouth. The mic is very visible in such cases, and the sound

is very "hot" and unmistakably amplified, with all the sound reaching the audience through speakers. This is suitable for speeches, assemblies, and some music concerts.

When producing a school or community play - particularly a musical - you may

wish to use microphones in a less obvious fashion. What you want to achieve in such a case is **sound reinforcement**, a somewhat subtler and more demanding art which will be my topic in the next issue of StageNotes. In that article, we will also be dealing with additional microphone types which have not been discussed here.

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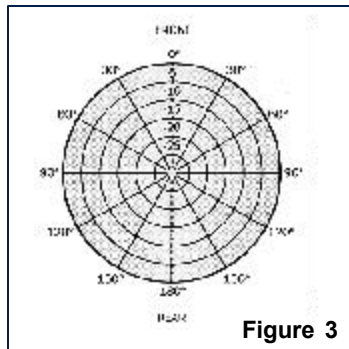


Figure 3

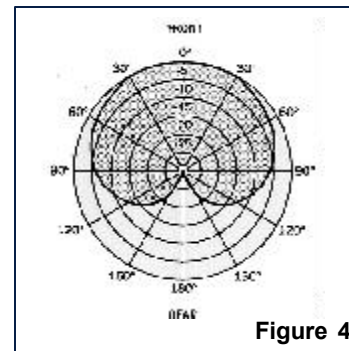


Figure 4

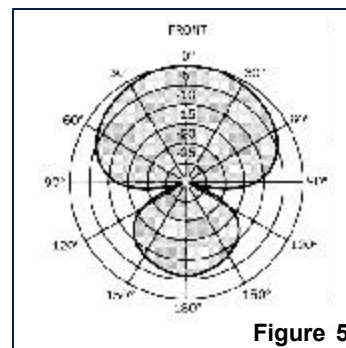


Figure 5

Figures 1 through 5 reprinted courtesy Shure Brothers Inc.

## New At NAMM

Recently, the National Association for Music Merchants held their annual trade show and convention at the Anaheim Convention Centre in California. NAMM primarily concentrates on the music industry, with more than 5,000 members in the U.S. and worldwide. Of course, there were many new and exciting audio products showcased at this convention, which I had the pleasure of attending. What follows are some of the items which I found interesting during my travels of the trade show floor.

### Microphones

*Electrovoice* has a few new microphones which captured my attention. The **CO2** is a miniature lavalier microphone with an "indestructible" cord and microphone adapter. This mic will be available with the miniature plug used in the wireless systems, or with a standard XLR (3 pin microphone) connector. It also comes in your choice of black or white, and can be painted to suit your particular colour scheme. (It was also suggested that instead of paint, make up could be used - with no ill effect to the microphone sound.) Because the cable is indestructible, you will have more assurance that less problems will occur with your wireless microphone systems during a show. Also, EV displayed their **CT30** boundary microphone which we shall be demonstrating and testing shortly.

*Audio Technica* also remains in the race with a new studio condenser, the **AT4041**

which has excellent response and very high SPL capacity. This allows use in high volume situations with clear sound in a studio environment. The other microphone that I found was the **AT 873**, a great mic for drum kits and even choirs in a live situation. The 873 is a great general purpose microphone suited, in fact, to many different applications and comes in a choice of pickup patterns.

### Mixers

*DDA* again leads the way in professional mixing consoles at a decent price. The **DDA CS3** console is a true LCR console (Left, Center, Right) with a new ergonomic sense (the "Pre Fade Listen" buttons are at the bottom of the rail, near your fingers while you are mixing, for example.) This console also comes equipped with the full range of mixing components including a parametric equalizer, submasters, and phantom power, to name a few. And it's all put together with the same *DDA* quality that is expected from this company.

*Mackie* introduced some new changes, and in fact, a brand new console. Newly revised are the **1202VLZ** and the **1402VLZ** which are upgrades from the 1202. Some of the new features include a sloped surface with "tape groove," a three-band EQ, and some innovative new bussing. (Mackie "bussing," or signal routing, is something which can be both profound and baffling. Essentially it allows you to send your sound to more places and in more ways than would normally be expected.) The **1402VLZ** has linear faders, (often referred to in the industry as a

"slidey switch") and 2 more mic inputs than the 1202. The **Mackie 1604VLZ** is a hybrid between the popular SR series and the original 1604 console. All 16 XLR mic inputs are now incorporated into the console chassis, with no add-on modules required. Also, there are now 4 separate mix busses prior to the main outputs, and the *Pre Fade Listen/After Fade Listen* capabilities of the SR consoles.

(Mackie is also prototyping a new larger console to be named the "SR40•8" - more information to be available later on in the year! Stay tuned...)

### Speakers

Once again *Electrovoice* leads the way with innovative power handlers in the speaker market. While not completely new, we did some comparisons with the *System 200* and found it to be one of the best sounding portable speaker systems around. Constructed of polypropylene, these lightweight cabinets have an excellent sound and are extremely portable. Also, the T52 has been redesigned into the **T52+** with new construction improving the bass frequencies, and *Neutrik Speakon* (Locking speaker) connectors equipped standard.

There were many more items at the show, and I'd love to chat about them, but space is limited in this newsletter. If you'd like any information about anything I mentioned here, feel free to give me a call, or drop me a line on my EMail account.

Al Bourke ([Al\\_Bourke@jfrost.com](mailto:Al_Bourke@jfrost.com))



### Goes Online

Jack Frost has a new location, our very own website. You'll find information on the products we sell, the services we offer, monthly sales and special discounted items. You can leave a message for any one of our sales or service personnel or check out past issues of StageNotes. So stop by for a visit and leave a note for the webmaster if you get a chance. Let him know what you think of our site.

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## Microphone Sale

Our staff have searched the world to find the best microphones for your dollar. We are pleased to present the fruits of their labour.

**Audio Technica AT873** \$ 258.00

High quality studio condenser hypercardioid microphone. Excellent for almost every live performance situation.

**Electro-Voice N/D257** \$ 145.00

An excellent handheld dynamic cardioid vocal microphone. Wonderful sounding. Don't miss this price opportunity.

**Electro-Voice N/D157** \$ 132.00

A good economical dynamic microphone with a cardioid pickup for handheld vocal work.

**Shure SM58** \$ 199.00

The industry standard vocal microphone. The 58 is a dynamic vocal microphone with a cardioid pickup pattern.

Of course, all these and more are available in rentals. Call for details. Prices are plus shipping and applicable taxes. Offer subject to change. Offer valid until April 30, 1996.