

OCTOBER 1975  
VOLUME 6 - NUMBER 5

# Recording engineer producer

INCLUDING: CONCERT SOUND REINFORCEMENT

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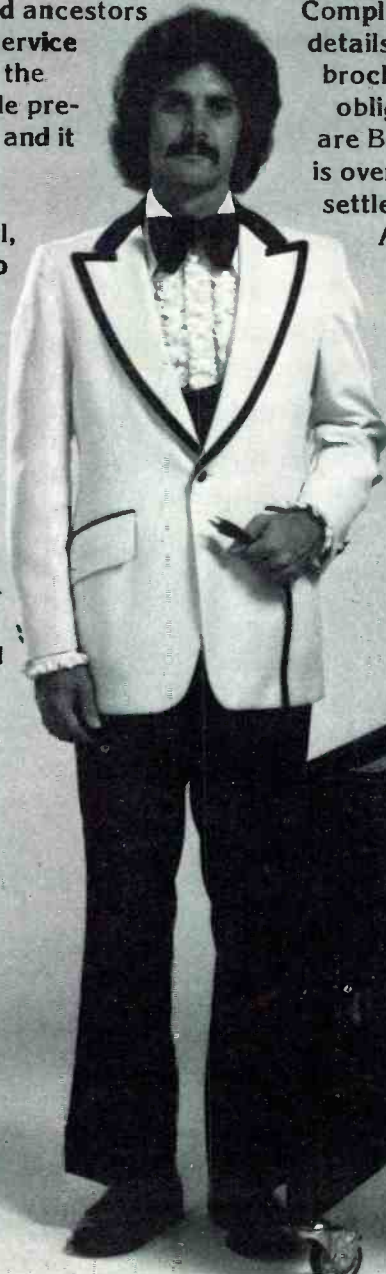
Versatility is built into the basic design. If you begin with a monaural, 1/4-inch version, you can move up to 2-track and 4-track work as easily as adding electronics modules and changing the heads. Motion sensing and improved edit controls make post-production more convenient. The rigid, die-cast transport plus sapphire guides give precision tape handling regardless of reel size.

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# RECORDING engineer/producer

OCTOBER 1975  
VOLUME 6 - NUMBER 5

- the magazine to exclusively serve the recording studio market . . . all those whose work involves the recording of commercially marketable sound.

- the magazine produced to relate . . . RECORDING ART to RECORDING SCIENCE . . . to RECORDING EQUIPMENT.



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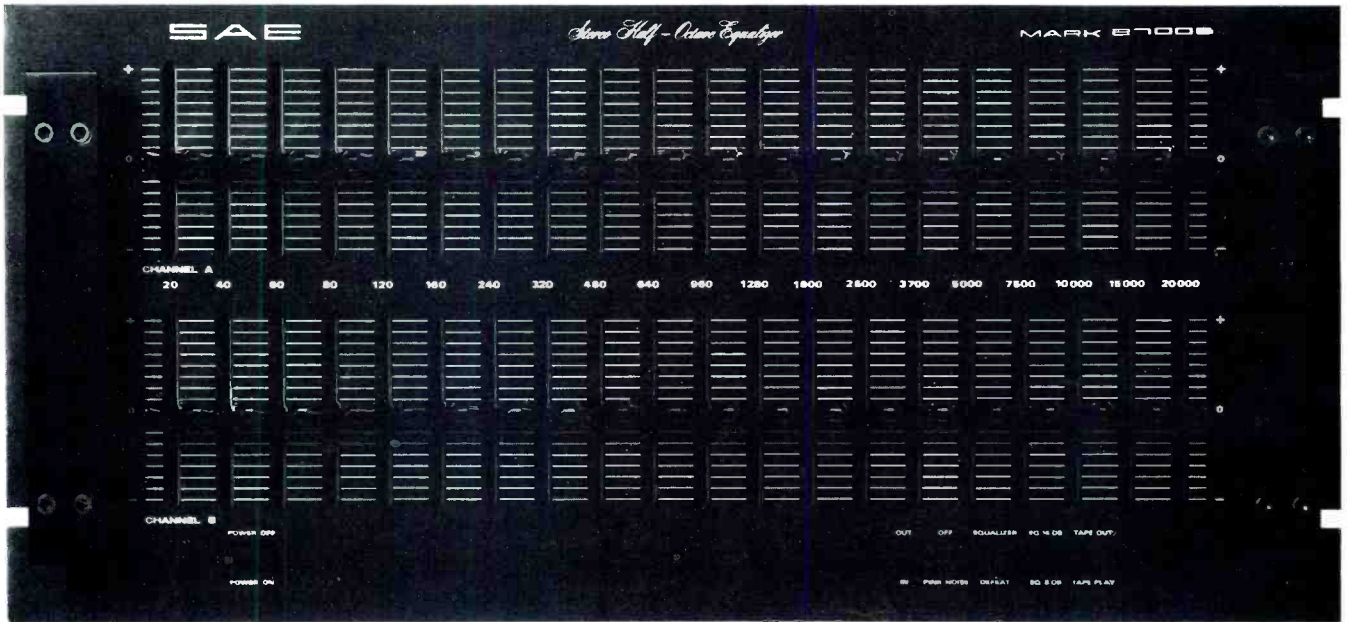
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# Flexible alternative.



SAE 2700B Professional Dual-Channel Half Octave Equalizer

At last, a Dual-Channel Half-Octave Equalizer. The result of years of SAE experience in home and professional equalization. Here are some of the outstanding features of the 2700B:

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**Low Noise.** High Q Toroid inductors in combination with low loss capacitors and low noise professional slide potentiometers result in circuitry offering greater than 100dB signal-to-noise ratio and accurate equalization curves.

**IC Power Supply.** Individual IC control for positive and negative power supplies further assures low noise circuitry and stability with changing line conditions.

The SAE 2700B Dual-Channel Half Octave Equalizer delivers +23dBm for recording applications, offers complete control, extremely low noise, accurate equalization, and the usual superb SAE quality.

## Technical Specifications:

Frequency Response.....	$\pm 0.25$ dB, 20H-20kHz
Total Harmonic Distortion at rated output from 20Hz to 20kHz.....	< 0.02%
Distortion at rated output with any 2 mixed frequencies between 20Hz and 20kHz, 4/1 voltage ratios.....	< 0.02%
Noise.....	100dB
Insertion Loss.....	Less than 1dB with controls centered.
Output at Clipping.....	>11 Volts into 600 ohms
Input Impedance.....	100k ohms
Shipping Weight.....	23 pounds
Dimensions.....	19" rack mounted front panel 8 3/4" H Chassis: 7" D

## The professional alternative.



Scientific Audio Electronics, Inc.  
P.O. Box 60271  
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Los Angeles, California 90060

Please send me the reasons why (including available literature) the SAE 2700B Professional Dual-Channel Half Octave Equalizer is the "Flexible Alternative."

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The audience can't see you, but they hear you. They depend on you to get that music to them. Undistorted. Balanced. Correct.

That's an art.

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A technological wonder.

Chock full of professional controls and features. The exclusive 4 x 4 matrix with level controls gives greater control of the sound than by driving speaker amps directly from the bus output.

It's standard equipment.

Like transformer isolated inputs and outputs. Dual echo send busses. And an input level attenuator that

takes +4 dB line level to -60 dB mike level in 11 steps. Plus five-frequency equalization.

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Because we think that some of that applause belongs to you.



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Box 6600, Buena Park, CA 90620

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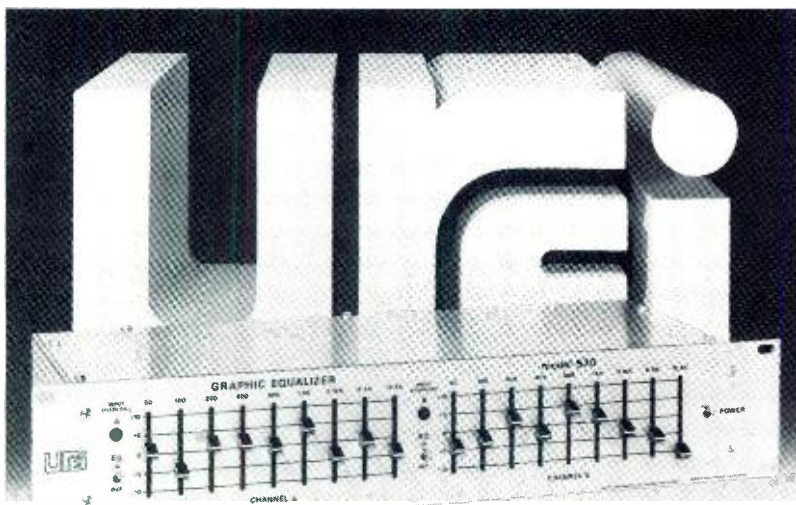
Circle No. 105



# New Two-in-One Graphic Equalizer

The Model 530 Dual Graphic Equalizer is the newest of our equalizer line. It has two completely independent Graphic Equalizers with a common power supply. Each channel begins with a differential input stage, includes nine variable active equalizers centered at each octave from 50 Hz to 12.5 kHz, and ends in an output amplifier capable of delivering +20 dBm into a 600 ohm load. The inputs may be fed from balanced or unbalanced sources. The 530 offers wide application possibilities in recording, sound reinforcement, radio and TV, commercial and home music systems. You'll like the two for the money price, too. UREI quality, of course.

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FROM: Bob Massie  
WKRK-TV  
Mobile, Alabama

*The article on "Phasing" on page 41 of the August issue of R-e/p was very interesting, but contained at least one glaring error. Phasing was not discovered in the mid 60's as stated in the article, it was used at least as far back as the late 50's in a session by Toni Fisher. The name of the song was 'The Big Hurt.'*

*I have used what the author describes as "Flanging" for many years in radio, and he is certainly correct when he says the electronic phasors are inferior to tape recorder phasing.*

*Keep up the good work with your publication.*

. . . thanks, Mr. Massie. You are quite right when you suggest that Phasing was used "at least as far back as the late '50s." Also, a little research has turned up the information that the Toni Fisher record "The Big Hurt" was done by Dave Gold at his Goldstar Studios in Hollywood.

More digging has led to the disclosure that a patent (U.S. Patent 3,757,058) describing A RECORDING ENHANCEMENT SYSTEM USING TWO TAPE PLAYING DEVICES RUNNING AT DIFFERENT BETWEEN-HEAD TRANSIT TIMES (ed:Phasing) has been issued to Brian D. Ingoldsbey. Brian, an engineer at MCA Recording Studios, as well as course instructor in recording at Sherwood Oaks Experimental College, it might be remembered, has written a number of articles in earlier issues of R-e/p.

Brian recalls that he accidentally discovered the Phasing technique in about 1954 when he was making some tape copies at the now defunct Glendale Pacific Recording Studios. He subsequently attempted to use the effect, he recalls, in a session with artist Drew Bennett (the group later became the "Arrows.") In his words, "It was a flop . . . people thought there was something wrong with the record."

. . . *what's that old line about an idea whose time has come . . .*—ed.





**AMPEX LOGS DELIVERY OF 300th MM1100**

(R to L) CBS Records Eric Porterfield, director of recording engineering, and Calvin Roberts, vice president, operations marketing, share a happy moment with two Ampex representatives, Al Slater and Frank Rush (far left) after taking delivery of an Ampex MM-1100 multichannel recorder. The 24-track professional mastering recorder represents the 300th machine shipped since Ampex introduced the

model in 1973. Also available in 8 and 16-track versions.

The MM-1100 ranges in price from \$15,000 to \$30,000.

**SLUTSKE, CARLILE, CHAPMAN IN NEW CETEC AUDIO RESPONSIBILITIES**

Mr. Robert Slutske has been appointed National Sales Manager of Cetec Consoles and Audio Components. His previous experience has included the position of National Sales Manager of Skirpan Light-

ing Control Corporation and Technical Director of the Honolulu Community Theatre.

Mr. Slutske will be responsible for the sales of Cetec studio, broadcast and live-media consoles, and the development of allied products in this field.

Mr. Thomas D. Carlile has been appointed as National Sales Manager for their well known line of Gauss loudspeakers. Prior to his new position, Mr. Carlile was Southern California Sales Representative for JBL.

As Sales Manager, Mr. Carlile will have total sales responsibility for the Gauss loudspeaker line, which includes professional, musical and high-fidelity loudspeakers and its recently introduced compression drivers.

Mr. Gerald Chapman has been appointed National Sales Manager for its line of Gauss high-speed tape duplication equipment. Mr. Chapman's background includes Western Director of Sales for Electro-Optical Mechanisms and positions with Bourns, Inc. and Tolex Computer Products.

**LEXICON OFFERS MANUAL ON APPLICATION OF DIGITAL DELAY TO SOUND REINFORCEMENT SYSTEMS**

Lexicon, Inc., manufacturer of digital

... continued overleaf

# "Evolutionary"

## Introducing the new Orban/Parasound Reverb

Over the last four years previous models of the Orban/Parasound Reverb unit have found their way into hundreds of radio stations, electronic music studios, schools, travelling shows, and recording studios small and large.

Our continuing research and development effort has now produced enough refinements to an already reliable and proven device to justify a new model.

The new Orban/Parasound 106CX Reverb looks exactly like its popular predecessor. It has the same ultra-compact dimensions, effective hum shielding, spring locking lever (for convenient portability), smooth four-spring sound, +4 dBm balanced output, true four-frequency midrange peaking equalizer (not just cheap tone controls), and a low \$695 price.

But we've managed to extend the effective high frequency response by another third octave compared to the older units. And a major redesign of the exclusive "floating threshold limiter" has not only

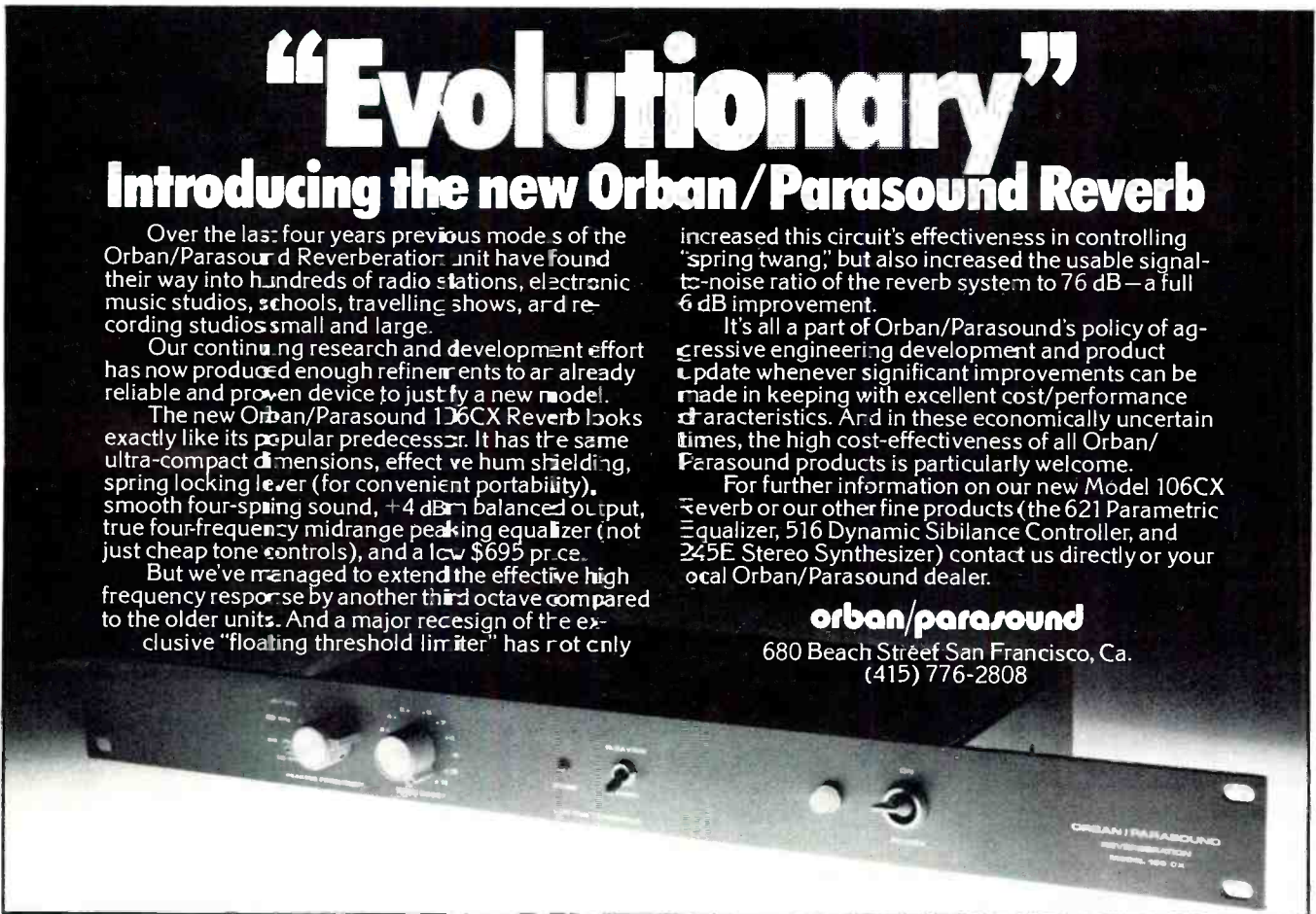
increased this circuit's effectiveness in controlling "spring twang," but also increased the usable signal-to-noise ratio of the reverb system to 76 dB—a full 6 dB improvement.

It's all a part of Orban/Parasound's policy of aggressive engineering development and product update whenever significant improvements can be made in keeping with excellent cost/performance characteristics. And in these economically uncertain times, the high cost-effectiveness of all Orban/Parasound products is particularly welcome.

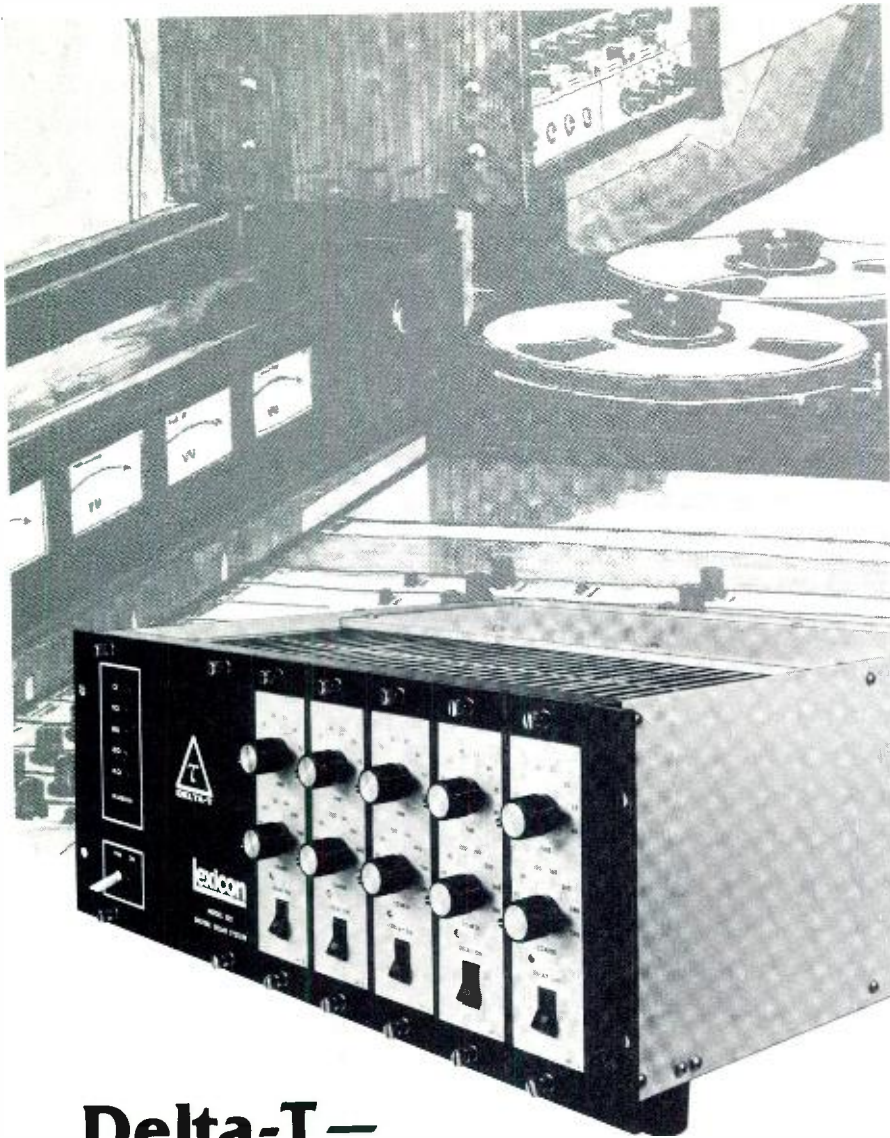
For further information on our new Model 106CX Reverb or our other fine products (the 621 Parametric Equalizer, 516 Dynamic Sibilance Controller, and 245E Stereo Synthesizer) contact us directly or your local Orban/Parasound dealer.

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That's what we provide in our new Series 102 Digital Delay Systems. We've been making high quality, reliable delay systems for five years and have learned how to do it better than anybody else.

Simply put, the Delta-T's 90 dB dynamic range and low distortion deliver a superb quality signal, leaving you free to creatively explore the powerful artistic potential of time delay. Discover for yourself, as leading studios such as Leon Russell's Shelter Studio have, how a Delta-T can thicken vocals and instruments, add slap or in-tempo percussive repeats, and provide ambience and spatial depth to the dry mono sources encountered at mixdown.

In the Delta-T 102 Series we have used our patented digital techniques to provide reliability, convenient features, and excellent performance at highly competitive prices. Let us help you define the configuration you need to get started. Call or write for more information.

# Lexicon

60 Turner Street  
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(617) 891-6790

delay systems, offers a free reference manual on the application of digital delay units to sound reinforcement systems.

Written by David L. Klepper, the application brochure will serve as a basic reference and technical guide for sound engineers or contractors in the application of digital audio delay units to sound reinforcement systems.

Topics covered include basic goals; intelligibility and sound energy time of arrival; the Haas or precedence effect; examples of systems requiring delay including central loudspeaker systems, simple distributed loudspeaker systems, supplementing central systems with distributed loudspeakers, unusual distributed loudspeaker systems, and stage monitor "foldback" systems for rock groups; delay equipment considerations; and a section on "lost causes" where delay will not necessarily help.

The reference manual treats each subject extensively and includes numerous diagrams of systems and applications to theaters, stadiums, music pavilions, churches, etc.

Interested individuals may request copies by writing Lexicon on their letterhead.

**LEXICON, INC., 60 TURNER STREET,  
WALTHAM, MASS. 02154 (617) 891-6790.**

### CD-4 HANDBOOK AVAILABLE

This new 28 page publication, although primarily intended as a point-of-purchase consumer educational tool, goes a long way to assisting the complete understanding of all of the forms of quad, as well as reporting on the latest CD-4 developments.

Single copies are available from:  
**JME ASSOCIATES, 6363 SUNSET BL.,  
HOLLYWOOD, CA 90028.**

### SHURE OFFERS GUIDE TO USE OF ITS NEW SOUND REINFORCEMENT PRODUCTS

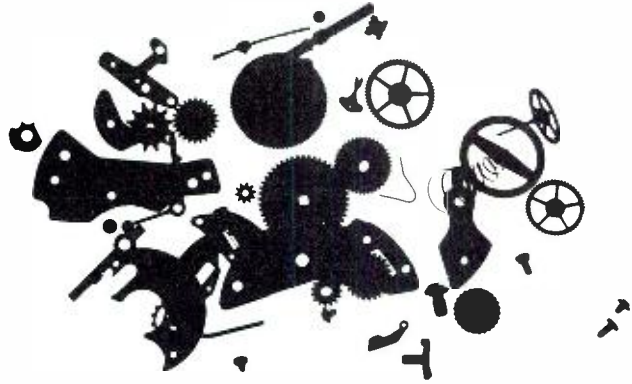
Shure Brothers Inc., is now offering an easy-to-use guide showing which products from its new SR Line of Professional Audio Equipment are needed to provide a complete, but not excessive, sound system for installations of virtually any size.

Called "Sound Ideas" the guide lists the SR components needed for both portable and permanent sound reinforcement systems for clubs, churches, meeting rooms, hotels, theaters, amusement parks, outdoor concerts, and large auditoriums. The systems described in the guide range from a small stage monitor to a "jumbo" high-powered, wide-range, 1,000-watt system.

Also included is a block diagram of



# component parts without coordination...

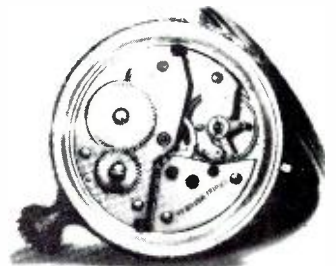


are just parts.

if it's to work right  
it has to be put together right

and that's what we do best

recording systems including:  
recorders  
mixing console  
echo  
power amps  
speakers  
microphones  
stands  
limiters  
headphones  
splicing block  
alignment tapes  
and mic panels



let us put it all together

SOUND SYSTEM COORDINATION BY

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each system, showing the interconnections of the individual components together with technical data such as the resultant frequency response of each system, the continuous RMS wattage output, and the number of available microphone inputs.

For a free copy of "Sound Ideas" (No. AL519), write:  
**SHURE BROTHERS INC., 222 HARTREY AVE., EVANSTON, IL 60204.**

## AUDIO ENGINEERING SOCIETY 52nd CONVENTION PROGRAM

October 31 – November 3, 1975  
Waldorf Astoria Hotel, New York City

### FRIDAY, OCTOBER 31 –

9:30 AM

Session A: Audio in Medicine

Session B: Disc Recording

2:00 PM

Session C: Signal Processing

Session D: Magnetic Recording

7:00 PM

Session E: Psycho Acoustics

Session F: Audio in Broadcasting

EXHIBITS OPEN: 1:00 PM to 9:00 PM

### SATURDAY, NOVEMBER 1 –

9:00 AM

Session G: Instrumentation

Seminar 1: (A) Compressors &  
Expanders

(B) Echo &  
Reverberation

2:00 PM

Session H: Electronic Music

Seminar 2: The New Tapes &  
Noise Reduction

7:00 PM & 9:00 PM

The New York Section:

"Those Magnificent Men and  
Their Music Machines"

EXHIBITS OPEN: 10:00 AM to 9:00 PM

### SUNDAY, NOVEMBER 2 –

9:00 AM

Session J: Sound Reinforcement

Seminar 3: Programming Synthe-  
sizers in the Studio

2:00 PM

Session K: Video Disc Systems and  
their Impact on Audio

7:00 – 8:00 PM

Social Hour

Awards Banquet

EXHIBITS OPEN: 10:00 AM to 5:00 PM

### MONDAY, NOVEMBER 3 –

9:00 AM

Session L: Transducers 1

Session N: Architectural Acoustics

2:00 PM

Session M: Transducers 2

EXHIBITS OPEN: 10:00 AM to 5:00 PM



## Two Electro-Voice engineers have a quiet discussion about the merits of dynamics vs. condensers.

The discussion is easy to settle because there are such obvious differences. Take our RE20 dynamic and our new CS15 electret condenser:

### RE20 Continuously Variable-D Dynamic:

It's designed to be virtually free of proximity effect and p-popping. And it's designed for as near perfect response 180° off-axis as the state of the art allows. Also, we planned it to take SPL's you wouldn't believe.

#### Can It Deliver?

In the anechoic chamber, the RE20 exhibits the widest, most uniform response curve of *any* available cardioid dynamic. The RE20's cardioid polar patterns are almost identical on axis and 180° off. It has excellent transient response.

#### And The Durability?

This microphone's grandfather could drive nails into pine boards and continue to perform unabashedly. The RE20 adds the ability to handle very high inputs. That's durability. We back this claim with the strongest dynamic microphone guarantee in the business.

### CS15 Single-D Cardioid Condenser:

It's designed to be light, to reject off-axis sound, and to provide controlled bass boost. In the recording, broadcast and sound reinforcement jobs where a swinging singer has two mike positions, close and closer, or the bell of a trumpet is surrounding the mike, it's designed to deliver wide, smooth response. And we've developed an electret that can endure SPL's that would have blown the charge off earlier electrets.

#### Can It Deliver?



In the anechoic chamber, the CS15 exhibits the wide, uniform on-axis response characteristics of the most expensive condenser microphones. Its off-axis response is excellent also. The microphone can be powered remotely with from 8 to 48 volts.

#### And The Durability?

The CS15 condenser is every bit as rugged as our most rugged dynamic.

We back this claim with the strongest condenser microphone guarantee in the business.

#### Specifications

	RE20 	CS15 
Model Number	RE20	CS15
Element	Dynamic	Electret Condenser
Polar Pattern	Cardioid	Cardioid
Response	45 - 18,000 Hz	40 - 18,000 Hz
Output Level (0 dB = 1 mw/10 dyn/cm <sup>2</sup> )	-57 dB	-45 dB
Max. SPL (1% THD or less at 1 kHz)	greater than 150 dB	141 dB
Impedance	50, 150, 250 ohms balanced	150 ohms balanced
Case Material	Machined Steel	Machined Steel
Sugg'd Resale Net Price (Slightly Higher in Western States)	\$300.00	\$198.00

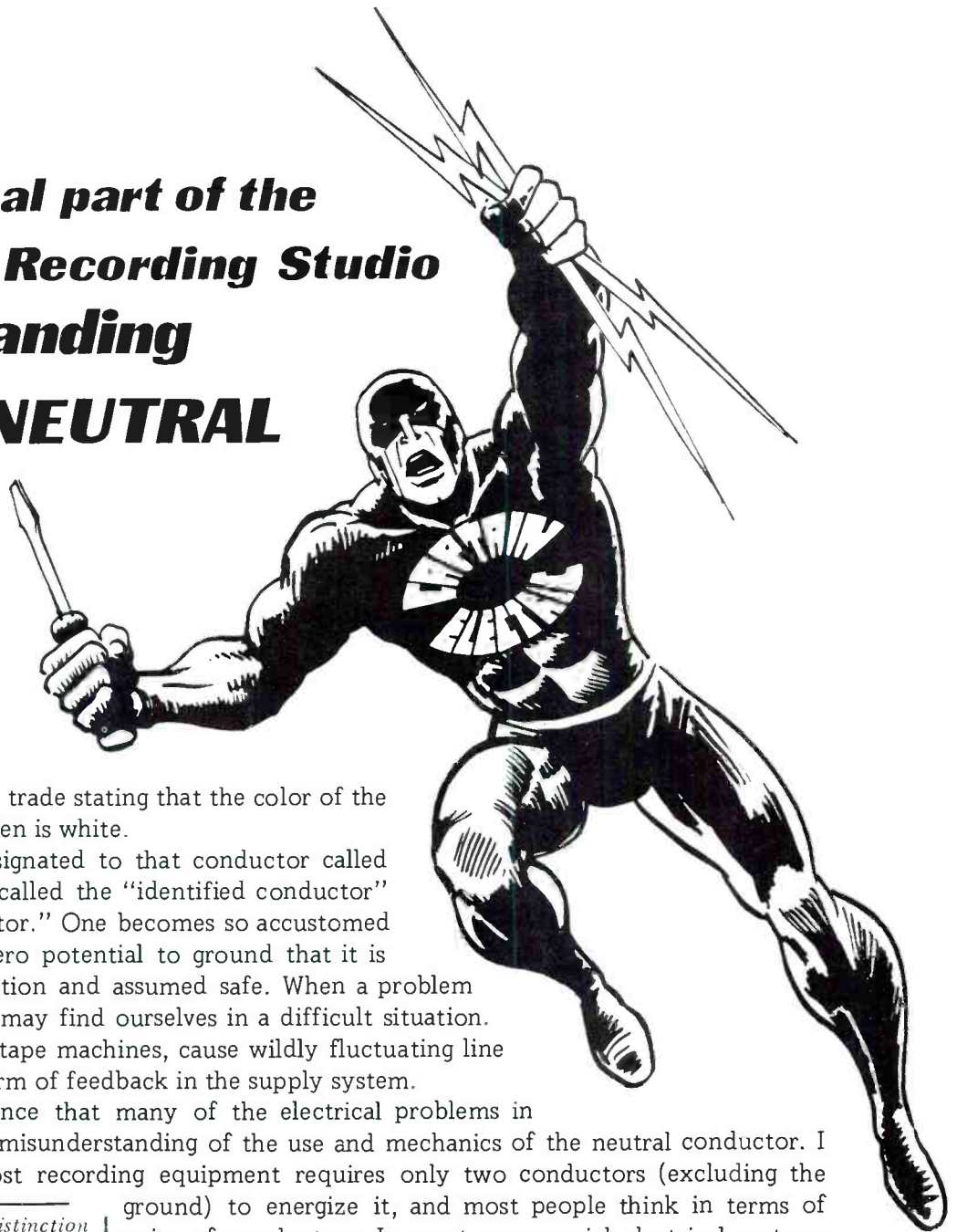
**Electro-Voice**® INC.

a **gulton** company

Dept. 1051RP, 674 Cecil Street,  
Buchanan, Michigan 49107



# The electrical part of the Recording Studio understanding **THE NEUTRAL**



by JERRY SIMON

There is a proverb in my trade stating that the color of the wire that kills men most often is white.

The color white\* is designated to that conductor called the NEUTRAL. It is also called the "identified conductor" and the "grounded conductor." One becomes so accustomed to having the neutral at zero potential to ground that it is often handled without caution and assumed safe. When a problem occurs with a neutral, we may find ourselves in a difficult situation. Neutral problems burn up tape machines, cause wildly fluctuating line voltages, and can cause a form of feedback in the supply system.

It has been my experience that many of the electrical problems in studios originate from the misunderstanding of the use and mechanics of the neutral conductor. I believe this is because most recording equipment requires only two conductors (excluding the

ground) to energize it, and most people think in terms of pairs of conductors. In most commercial electrical systems that have a neutral, the neutral is "shared" by other "live" AC conductors. It is this sharing that escapes consideration, partly because it is unseen at the outlet into which we plug the machine, and also because the machine operates in spite of our lack of understanding of the neutral. Our discussion of the neutral is directed toward the *mechanical installation* as well as its *electrical function*, and possible *malfunction*.

An electrical power distribution system originates at some remote generating plant and transmits power through a maze of rods, cables, transformers and sub-stations, through rainstorms and sunshine until it arrives at the transformer on the . . . . .

\*In England white is hot, black or blue is designated for neutral. Green, or green with yellow, is ground (earth), the same as in North America.

---

*Jerry Simon has earned great distinction as the electrical consultant and electrical constructor of some 50 recording studios, disc-cutting rooms and remote vehicles in the United States and Canada.*

*Many of these projects are the 'super studios' designed by WESTLAKE AUDIO, and EVERYTHING AUDIO, among others.*

*'Captain Electric' is a partner with Dick Gould in:*

**ELECTRICAL CONSTRUCTION CO.**  
16746 Gilmore Street  
Van Nuys, CA 91406  
(213) 787-3679

power pole outside the studio. See Figure 1. It is at this transformer that the system becomes most visible. We shall examine that part of the electrical system that starts at the transformer, enters the studio, and is distributed to the outlets, for it is here that the neutral is born, referenced to ground, and is distributed through the facility alongside the hot conductors, parallelling but not common to the grounding terminals which also appear at each power outlet in the studio.

**WHAT IS "THE NEUTRAL?"**

At the transformer, high voltage electrical power is usually converted to either of two common systems used both in the USA and Canada. Figures 2 and 3 show the 120/240 volt, single phase, 3 wire system; and the 120/208 volt, 3 phase, 4 wire system.

By "the neutral," we are referring to the grounded return conductor common to all circuits in a single or three phase electrical system. It is intended to have a potential such that the potential differences between it and each of the other conductors in the system are approximately equal in magnitude and are equally distributed in phase.

Notice that the neutral is grounded at the transformer tap. This is true whether the transformer is owned by the serving agency or the studio itself. The serving agency will normally ground the neutral at the transformer, however there are occasions where the neutral is grounded a span or so away from the transformer. The studio does not have the same privilege.

The letter "X" in the diagrams indicate transformer taps on the secondary winding. The letter "H" is used for primary taps. This is an industry wide practice in both the US and Canada. From the serving agency's transformer the neutral is connected to the studio's service entrance facilities.

**THE SERVICE POINT**

The place where the AC power is connected from the transformer to a consuming facility (the studio) is commonly called the SERVICE POINT, sometimes known as the service drop, or simply the service. The purpose of the equipment at the service point is to provide primary protection for the electrical system and to provide a means to cutoff the supply. There is also a meter which measures the consumption of electrical current.

Figure 4 is a diagram of common service point equipment used in the US and Canada. The drawing shows the type

normally used for commercial establishments such as studio operations. However, the information is essentially the same for other types of service equipment, such as switchboards with multiple distributions, or a single family dwelling service.

Notice that the neutral is grounded again. It is now grounded in two places; the serving agency's transformer and the studio's service point. It should not be grounded again. The grounding of the neutral at the service point provides a safety factor.

**THE DISTRIBUTION CENTER**

The power from the service point then is routed to the distribution center which houses the overcurrent and protection devices which provide a disconnect means for the ungrounded conductors of a circuit (usually called the live AC, or hot, conductors).

It is seen in Figure 5 that at the distribution center all circuit neutrals are connected to the main neutral via the neutral bus and the main identified conductor.

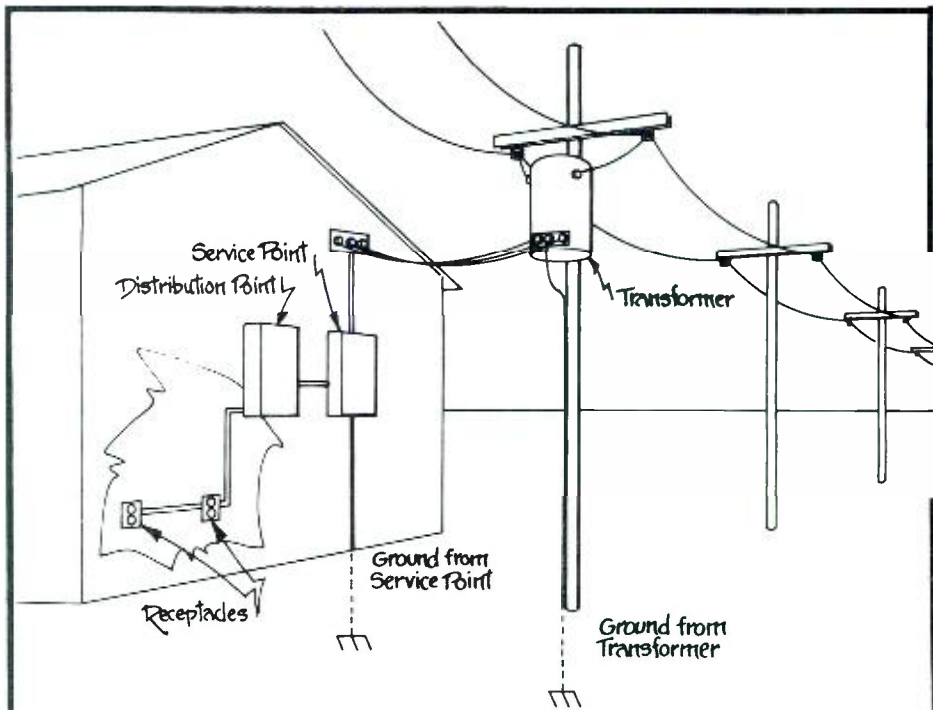


Figure 1 ELECTRICAL POWER DISTRIBUTION SYSTEM

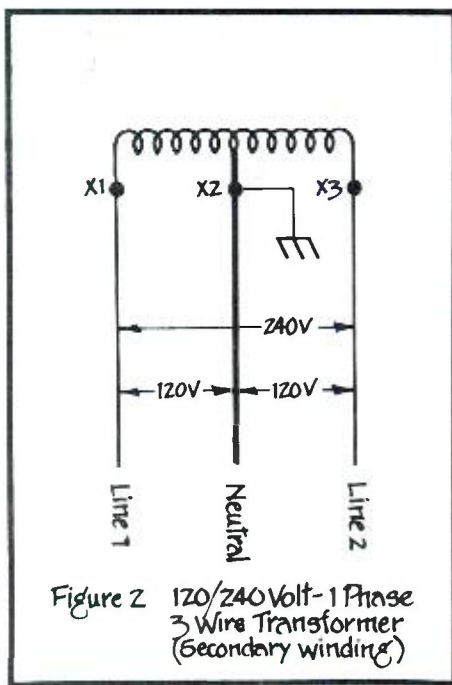


Figure 2 120/240 Volt - 1 Phase 3 Wire Transformer (Secondary winding)

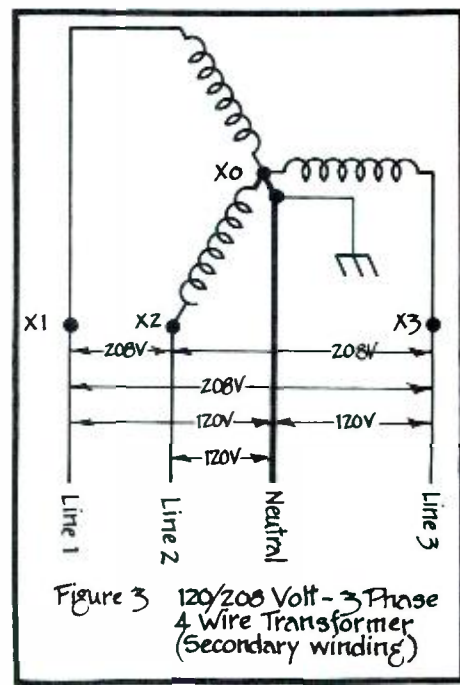


Figure 3 120/208 Volt - 3 Phase 4 Wire Transformer (Secondary winding)



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115HT

\*One 15" driver, one mid horn, two Piezo tweeters in a 8 ohm enclosure. \$275. list price.

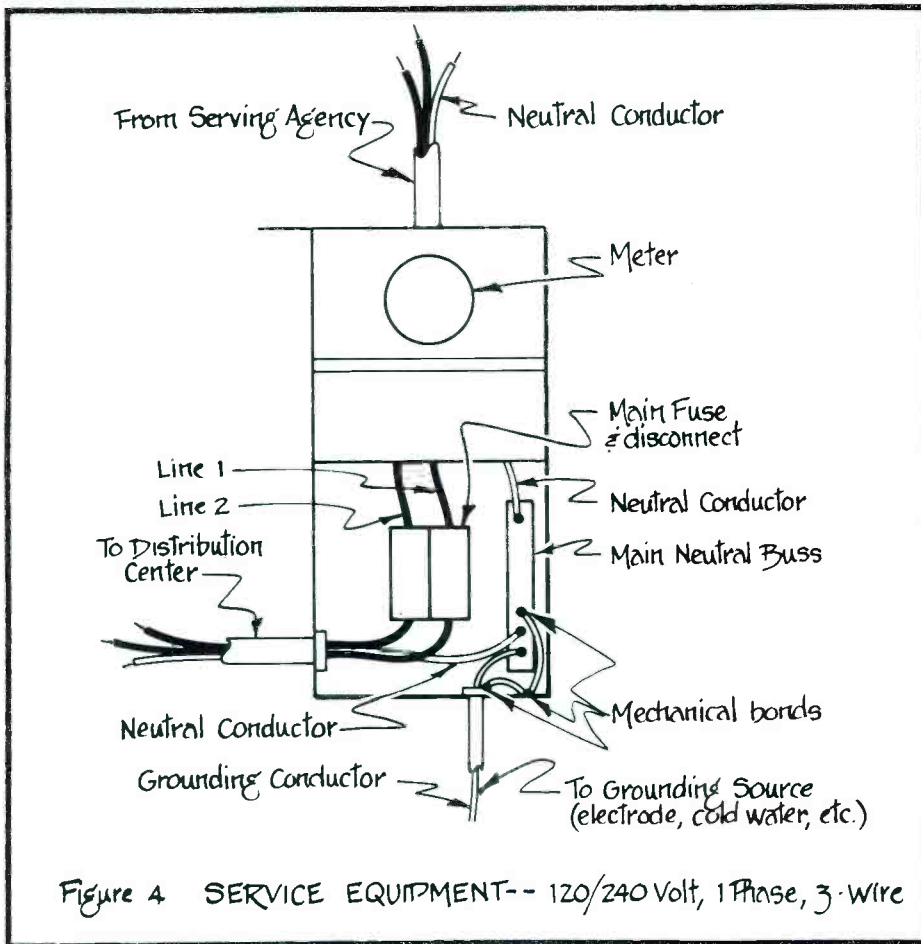


Figure 4 SERVICE EQUIPMENT-- 120/240 Volt, 1 Phase, 3-Wire

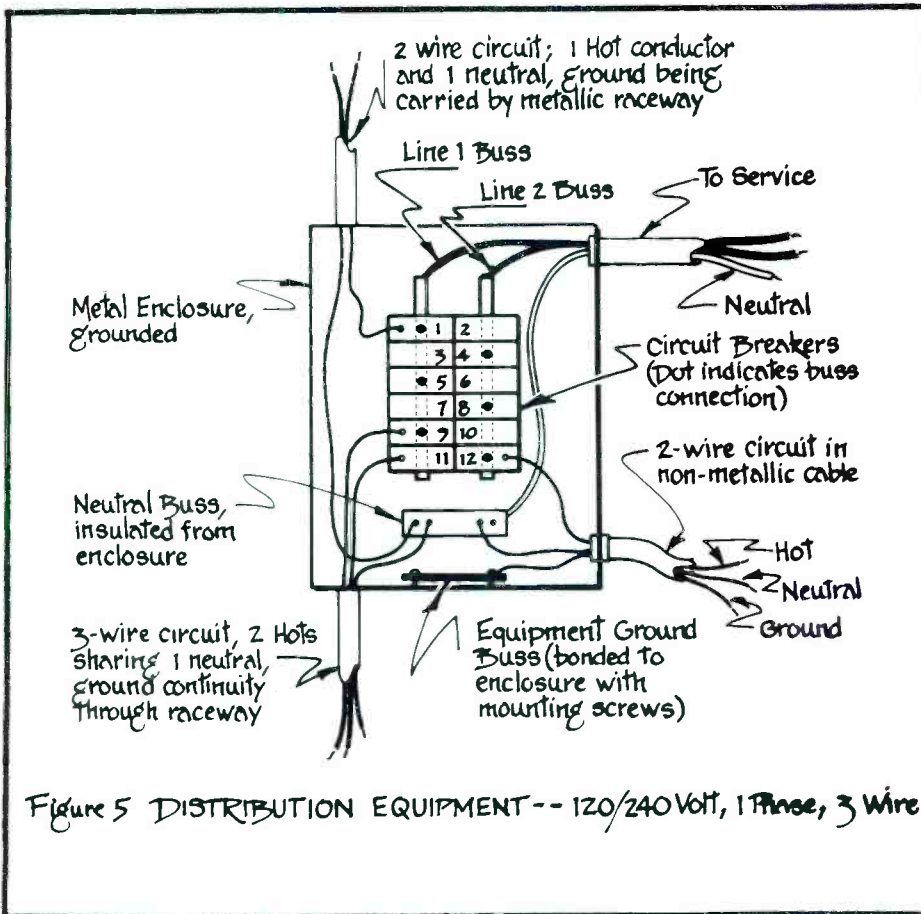


Figure 5 DISTRIBUTION EQUIPMENT-- 120/240 Volt, 1 Phase, 3 Wire

At this point we are made aware of two principal types of grounds found in electrical distribution systems: the "electrical" and "equipment" grounds. The electrical ground refers to the grounding of the neutral conductor at the transformer by means of a heavy wire (called the grounding conductor) connected to a grounding source, such as a buried water pipe or other metallic member buried in the earth.

"Equipment" ground is a general term denoting all other types of ground. Included under this heading is the term "mechanical" ground, which refers to the continuity and bonding methods used to insure that metal enclosures and raceways are at ground potential. "Equipment" ground may also infer the grounding of a device, machine or building by means of a separate grounding conductor.

At the distribution center and sometimes at the service point a ground buss may be installed. This is not the same as a neutral buss. All grounding conductors being used for mechanical grounding purposes will normally terminate at the ground buss. In electrical systems where the installation is constructed with metal conduit or metal covered cable, the conduit or cable covering itself may be used as the mechanical grounding means.

#### THE RECEPTACLE

A receptacle is a device into which a plug may be inserted for the purpose of connecting current using apparatus to the electrical supply. Receptacles are manufactured in many forms and configurations based on voltage, current, phase, grounding, and usage requirements. Our interest is directed to the receptacle most commonly used in recording studios in North America, specified as a "15 ampere, 120 volt, grounding, 2 wire, parallel blade, plug-in, receptacle." Figure 6 shows how this receptacle is wired into a single phase, 3 wire distribution system.

This receptacle requires two conductors to energize it; a hot and a neutral. It also requires grounding to meet code. The grounding may be provided in any of the following ways:

1. Attaching a conductor to the grounding terminal of the receptacle and to the mechanical grounding source at the distribution panel.

2. Attaching a conductor to the grounding terminal of the receptacle and to the metallic outlet box which supports it and using the metal raceway as the path to the grounding source.

3. Attaching a grounding conductor of a non-metallic cable to the grounding terminal of the receptacle and to the grounding source.

It must be kept in mind that the neutral terminals are not connected to the grounding terminals at the receptacle in any way. These are two separate systems



## New Interface Electronic Crossover

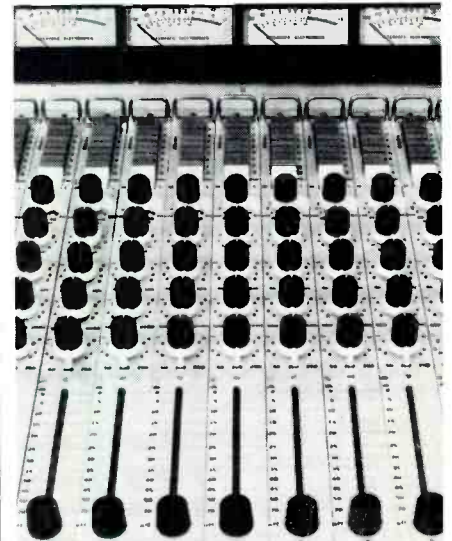


Three-way tuneable crossover has crossover points fixed at 3db. down. It is tuneable 130-1700 and 110-14000 Hz, with all outputs in phase at all frequencies. No null crossover and 12 db/octave Butterworth response. It has 600-ohm transformer outputs at 8 volts rms maximum. Voltage gain is 2 maximum. Distortion under 0.1%. Rack mounted panel measures 1 3/4". Price \$295.00.

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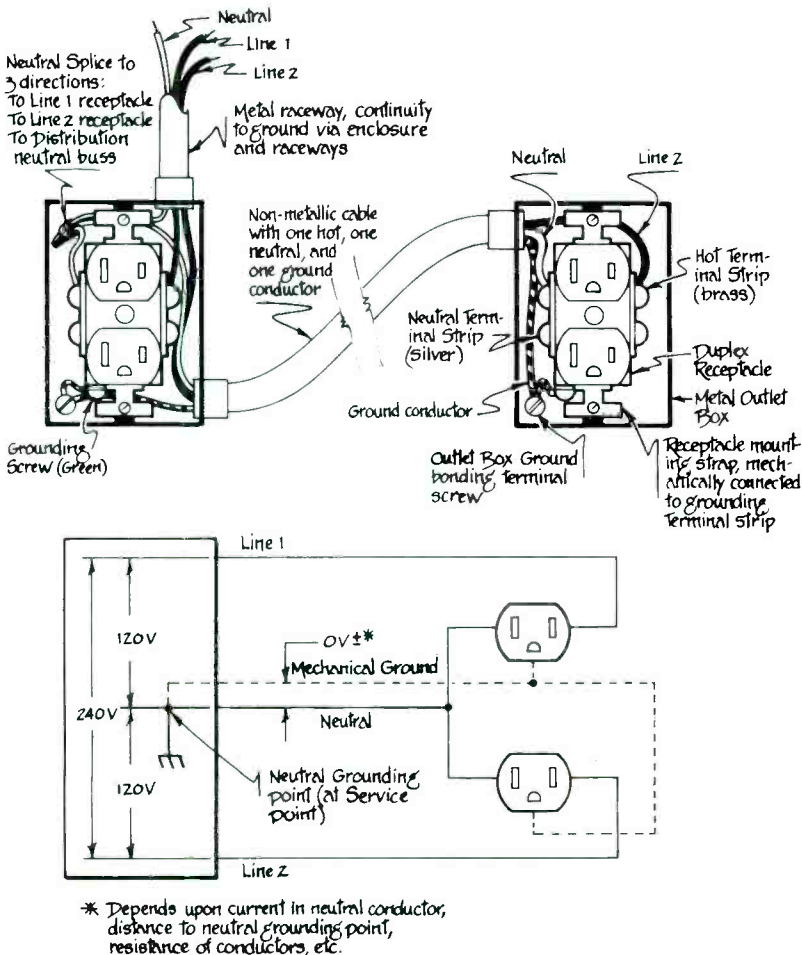


Figure 6 RECEPTACLE WIRING, 3-WIRE CIRCUIT

even though their potentials to the hot conductor may be the same. As stated earlier, the neutral and the ground are connected together at the main service point as a safety measure, and should not be connected together at any other point in the system. They should be considered as two distinct systems and are not interchangeable.

This, then, concludes our brief discussion of the mechanical aspects of the neutral conductor in relation to the live AC conductors, the grounding system, and the overall electrical supply system. With these factors in mind we can better approach an understanding of the neutral conductor's electrical performance.

## THE NEUTRAL AS PART OF A CIRCUIT

"One ampere of current applied to the load equals one ampere of current returned from the load," is a rule of the trade. Figure 7 shows a typical two

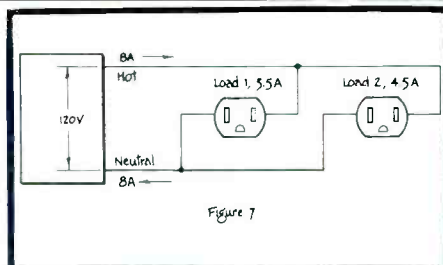


Figure 7

wire circuit, where there is one hot conductor paired with a neutral. The current in the hot line is equal to the current in the neutral.

Figures 8 and 9 show a typical 3 wire system, where the two separate hot lines share a common neutral conductor. The mechanics may be a little easier to understand if a direct current (DC) system is considered first.

In Figure 8 conductor A is positive and conductor B is negative. The neutral maintains a potential halfway between A and B and is negative with respect to A and positive with respect to B. The

current tends to flow from A to the neutral and from the neutral to B. In a balanced system loads 1 and 2 are equal, each drawing 4.5 amperes. The 4.5 amperes taken by load 1 flows through to load 2 and then back through conductor B to the source. Under these conditions the net current in the neutral conductor is zero, and the loads are said to be balanced.

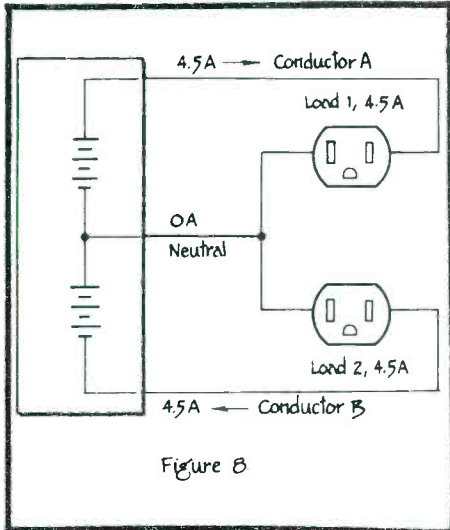


Figure 8

Figure 9 shows the conditions existing when load 1 on the positive side of the system draws 10.0 amperes and load 2 on the negative side draws 4.5 amperes. Under these conditions the extra 5.5 amperes taken by load 1 must flow back through the neutral conductor to the source. If load 1 were 4.5 amps and load 2 were 10.0 amps the extra 5.5 amps would FLOW OUT through the neutral to load 2. The current may flow in either direction. The neutral carries the difference of currents drawn by the two loads.

Thus, for each ampere generated, one ampere is returned. In an AC system the principle remains the same, except that the polarity reverses every 1/2 cycle.

... continued overleaf

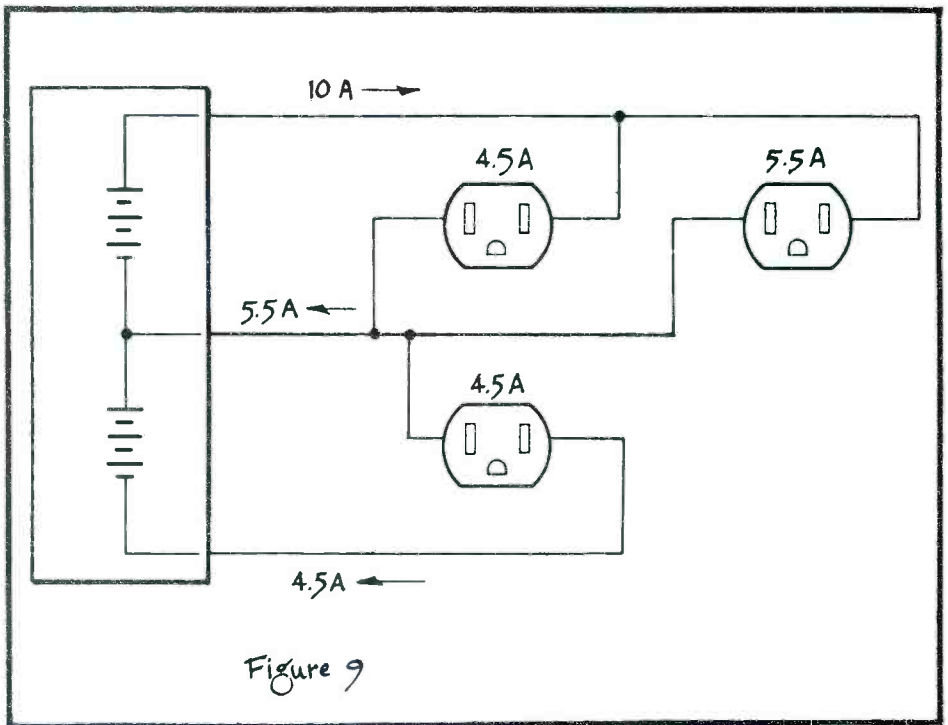


Figure 9

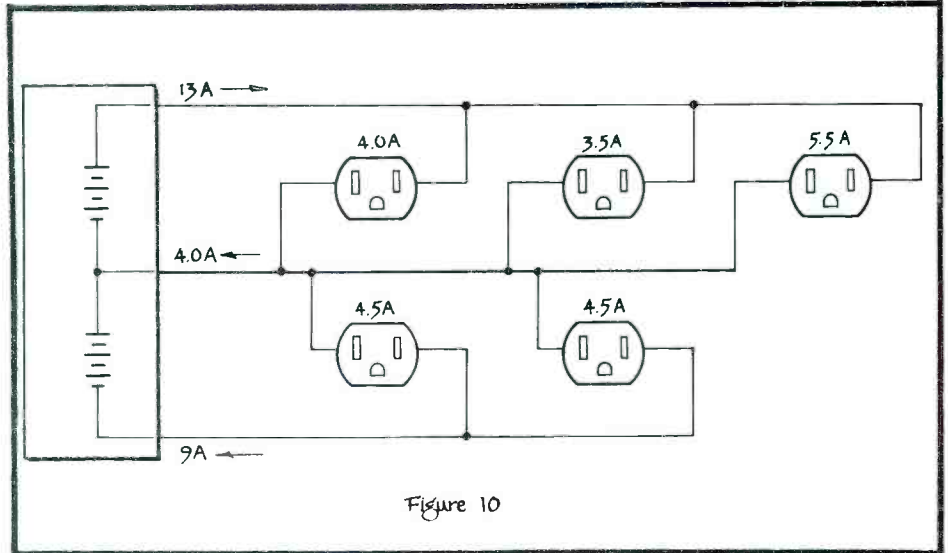


Figure 10

- OC = Vector of L1 representing current.
- OB = Vector of L2 representing current.
- OA = Vector of L3 representing current.
- ON = Resultant Neutral of L2 & L3
- BN = OB (Equal sides of a Isosceles Triangle)
- $\theta$  =  $60^\circ$  (you work out the proof)

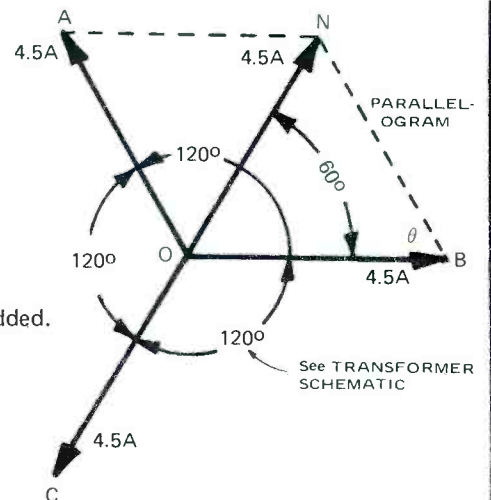
OR BY TRIGONOMETRIC FORMULA:  
 $ON^2 = BN^2 + OB^2 - 2(BN \times OB \times \text{COSINE } \theta)$   
 $\text{COSINE } \theta = \text{COSINE } 60^\circ = 0.5$   
 $ON^2 = (4.5)^2 + (4.5)^2 - 2(4.5 \times 4.5 \times .5)$   
 $ON^2 = 20.25$

'ON' = 4.5 AMP. representing current on neutral before load of tape machine 1 is added.  
**CURRENT IN NEUTRAL AFTER L1 LOAD IS ADDED**, resultant "ON" is in a direction  $180^\circ$  opposed to 4.5 AMP Vector "OC". The resultant of diametrically opposed vectors is the difference between their values.

"OC" - "ON" = Resultant Neutral  
 $"4.5" - "4.5" = 0$

Total load on Neutral after 3 balanced is 0 AMP.

THREE OUTLETS ON A 4-WIRE CIRCUIT: 120/208 VOLT - 3 OR 4 WIRE





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Figure 10 shows a more general case, where there are an unequal number of outlets on each line of a 3 wire system. The resultant current through the neutral is the difference of the sums of the currents in the two hot lines.

A 3 phase, 4 wire system is similar to a single phase 3 wire system, except that the phase displacements must be accounted for. Figures 11 and 12 show a 4 wire circuit, with three hot conductors and a common neutral. The neutral carries the difference of currents as in a three wire circuit, but the currents in each of the hot conductors are displaced from each other by a phase difference of 120°, so simple addition and subtraction of the currents is not valid. Calculations of total current in the neutral conductor are normally done using vector techniques.

For all practical purposes the neutral can be considered as carrying the current of the hot conductor with the heaviest load. This is because of the trade practice that requires sizing the neutral conductor according to the largest current load it may be required to carry. If, in Figure 12, line 1 and line 3 were disconnected, the neutral current would equal the line 2 current of 15.5 amps.

### THE OPEN OR FLOATING NEUTRAL

An "open" or "floating" neutral is the term given to conditions when the continuity of the neutral conductor to the transformer is interrupted.

Figure 6 shows the normal hookup of a receptacle and the mechanical method in which the neutral is shared in a three wire circuit. Notice the three-way splice in the neutral conductor at the first outlet. That is required by code. If the receptacle connected to line 1 were to be removed it could be done without opening the neutral connected to the receptacle on line 2. If there were a load connected to the receptacle of line 2 and the neutral were opened, a possible hazard would be created.

In a two wire circuit as in Figure 13 the break will act like a disconnect and the electrical equipment connected to the circuit will turn off. If the neutral conductor should happen to contact a grounded surface, the equipment will continue to operate, and the current will travel down the surface to the grounding terminal and back to the neutral conductor at the main service point. Should the grounded surface be touched under these conditions there can be a shock hazard. This type of hazard is called "touch voltage."

Even though the human body has a relatively high resistance to the flow of electrical energy, some energy will flow through the body if it touches an energized surface. The degree of shock is dependent on the voltage, the current through the load, and to what extent the

body is grounded, and its resistance.

There is also the possibility of voltage changes occurring with an open neutral. The neutral, in just touching or lightly contacting a grounded surface, encounters a higher resistance in its return path to the transformer. With the passage of time the conductor tends to oxidize at the point of contact and the resistance is continually increased. The neutral, with its flow of current through a resistive contact point, begins to heat up at that point, causing the oxidation to accelerate until the conductor burns and breaks contact with the grounded surface altogether. During this time the voltage and current delivered to the load vary with the resistance of the circuit.

There are additional factors to consider in the event of an open neutral for both three and four wire systems. If the loads in all lines are equal and balanced, there is no current effectively flowing in the neutral conductor and the problems associated with an open neutral are not apparent. But as soon as someone turns off a tape machine plugged into line 1, or turns on an electric organ plugged into line 2, or in some way unbalances the loads on the entire system, serious problems can develop.

Referring to Figure 14 we have an unbalanced load situation on a 3 wire system. Normally the voltage on each line is 120 volts, referenced to the neutral, with 240 volts across the two hot conductors.

We can figure the effective resistances of each load by means of Ohm's Law:

$$R = \frac{E}{I} \text{ The resistance of load 1 is}$$

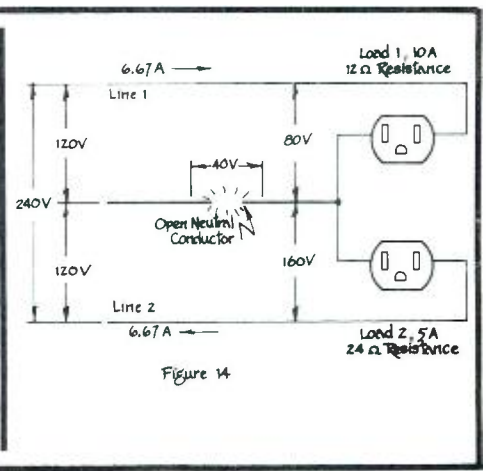
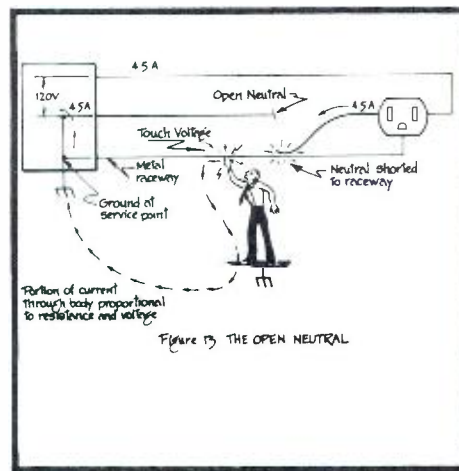
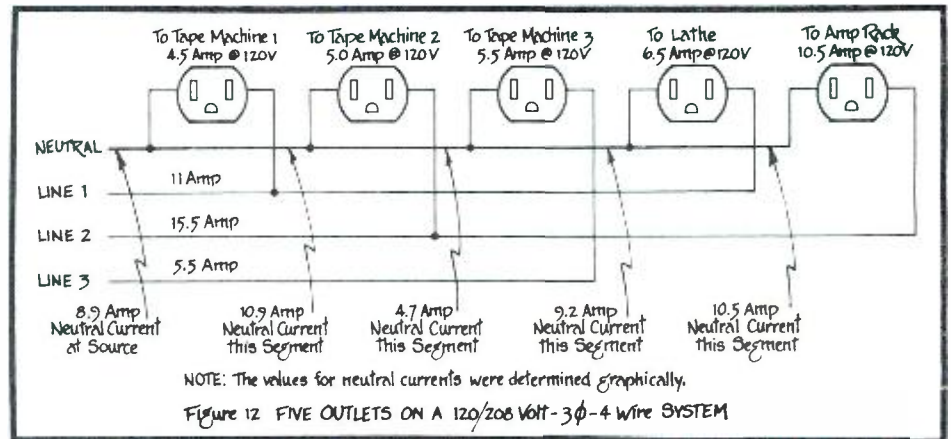
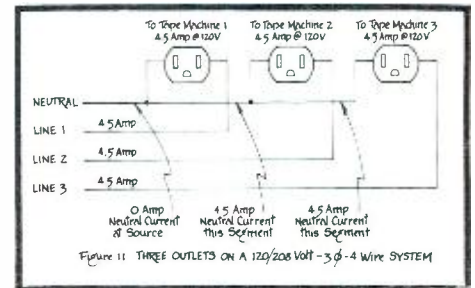
$$\frac{120V}{10A} = 12 \text{ Ohms, and load 2 is}$$

$$\frac{120V}{5A} = 24 \text{ Ohms.}$$

If the neutral conductor is opened, the full line 1 to line 2 voltage appears across the two loads in series, without a ground reference between the loads, and a common current is shared by both loads. This current is (also by Ohm's Law):

$$I = \frac{E}{R} = \frac{240V}{12+24} = \frac{240}{36} = 6.67 \text{ amps}$$

This new current, encountering the resistances of the loads causes abnormal volt-





ages to develop across them; load 1 = 12 Ohms and  $E = IR = 6.67A \times 12 = 80V$ , and across load 2 the voltage is  $240V - 80V = 160V$ . The more unbalanced the loads are, the greater difference in voltage across the loads will be. In many instances it can approach the full 240 volts across one load and virtually zero volts across the other. How long will a 120 volt tape machine or amplifier operate on 240 volts?

If, in trouble shooting, an open neutral and the neutral strip of the receptacle should be touched, one could be subjected to a full voltage shock. That can hurt. I know. When dealing with an open neutral extreme caution should be used. Turn off the power. Trouble shooting an open neutral can be a time consuming task.

### THE NEUTRAL AND GROUNDING

In North America the customer is required to ground the neutral at the service. In some countries the customer is prohibited from doing so without permission from the serving agency. In those countries the serving agency provides the customer with a grounding source. All ground conductors and equipment grounds must ultimately connect to that source. Their reasoning is based upon expectations that a difference of potential would exist between the two (or more) grounding points and result in potentially dangerous circulating currents.

The intent of both types of grounding systems is the same: Safety, just the techniques are different. The Canadian code (CSA) has one of the best descriptions of the object of grounding:

A. To protect life from the danger of electric shock, and property from damage;

B. To limit the voltage upon a circuit when exposed to higher voltages than that for which the circuit is designed;

C. In general to limit AC circuit voltages to ground to 150 volts or less on circuits supplying interior wiring systems;

D. To facilitate the operation of electrical apparatus and systems;

E. To limit the voltage on a circuit to a safe level which might otherwise be exceeded through exposure to lightning.

Some other descriptions of the object

of grounding:

– To reduce the hazards to life and equipment due to failure of a transformer, or a cross between primary and secondary wires.

– Earthing is primarily a means of keeping neutrals at about earth potential.

– Reduction of voltage strains on apparatus.

– System grounding provides a measure of safety should there be a fault outside the building.

– It is safer to keep a system ungrounded. However systems do not remain ungrounded for long (insulation deterioration, moisture, etc.).

Any accidental ground on the already grounded conductor will have no effect, while any ground on the ungrounded conductor will produce a short circuit. The overload protection will open the circuit.

There are many more opinions but they all seem to describe the need to insure safety from:

1. Outside voltage transients.

2. Short circuits on apparatus.

3. Protection of persons from exposure to surfaces at greater than earth potential.

It should now be apparent that the neutral and the ground, though at the same potential and interconnected at points, serve different functions. They are not one and the same and should be connected to each other only with full knowledge as to the *potential* effects and with permission of the enforcing authorities.

In the recording studio, grounding audio equipment serves a different purpose than electrical grounding. Generally the grounding system for recording equipment (called a "technical" ground) is desired for the following reasons:

A. To assure that all equipment operates at the same ground potential so as to eliminate circulating currents between components (ground loops).

B. For shielding.

C. For transient suppression.

Some studios use the electrical ground for technical ground. Some successfully, and some not. The differences of the functions of the two grounds should be considered before one ground point is established for both systems. Much more can be written about grounding, but that is a subject for another day.

The electrical system is rarely at rest. When a single tape machine is started or the volume on the monitors is increased, a chain of events occur that affects the whole electrical system. There is mutual capacitance (sometimes called feedback) between conductors. When the current in the neutral changes, a change in other nearby conductors can be induced. Earth is considered to be at zero potential, but in fact rarely is. There are differences in voltage over the surface of the earth itself

as well as currents. Seasonal changes have effects on the conductivity of earth as well as causing demands on electrical supply. Summer heat and air conditioning may cause lower average voltages than in the spring. With lower voltages come more pronounced effects on the system by load demands and changes. The starting of a single copying machine can send a spike throughout an entire building's electrical system.

Recording engineers, through continuous diligence, with trial and error, with insight, bailing wire and chewing gum, and with scientific wild-ass guesses, have kept many studios operational, in spite of the inherited electrical systems. Not all problems originate in the electrical system. Some come from within the audio system itself. But it is easier to maintain a well functioning audio system if the basic electrical supply system is dependable and predictable. In my opinion the neutral is the key to making the system dependable and predictable.

The purpose of this article is not to make the engineer an electrician. The basic features and properties of electrical systems described here are only the most commonly encountered in this country. There are also many variances and exceptions. Hopefully this article will make him more familiar with the supply system his electrician is installing.

### REFERENCE MATERIAL

National Electrical Code, 1975  
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Regulations for the Electrical Equipment of Bldg. 14th Edition (Great Britain)  
Canadian Standards, 17th Edition  
Handbook of Simplified Electrical Wiring Design, John D. Lenk (Prentice-Hall)  
Industrial Electricity, Nadon and Gelmine  
Van Nostrand Company, Inc.  
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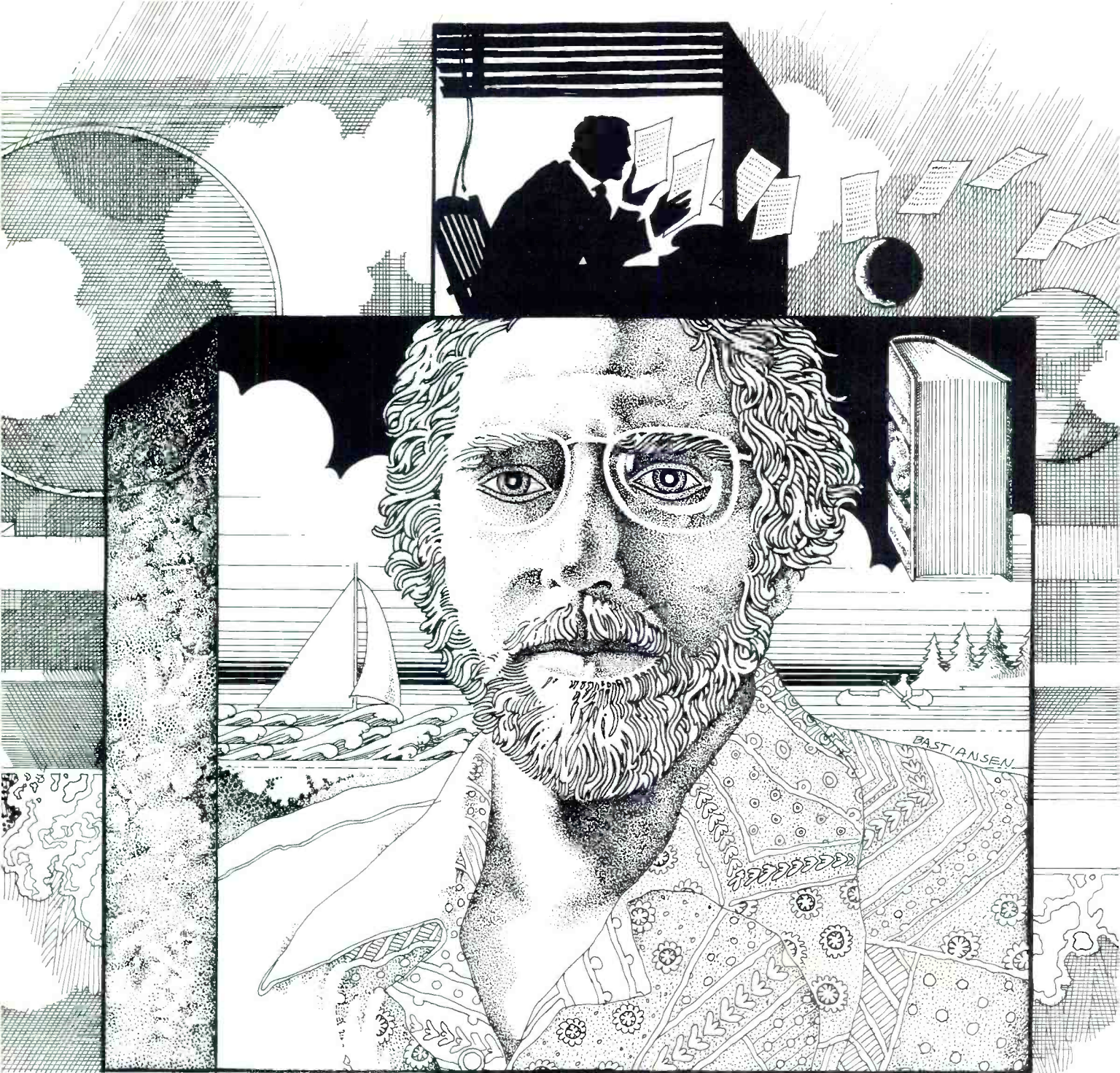
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BY  
ROB LEWIS  
CERWIN-VEGA

"Dancing Madness" read the banner headline in a recent issue of *Rolling Stone*, which then went on to document the disco craze that is sweeping the nation as furiously as the "English Invasion" did a dozen years ago. Almost overnight, music trade papers are running whole sections on disco music (complete with separate hit charts), record companies are courting disco jocks as ardently as they do radio program directors, and club owners from Hollywood to Hoboken are abandoning old entertainment formats in a rush to cash in on the craze.

Whether this phenomenon is destined to be a short-lived fad or an enduring part of the entertainment scene isn't clear yet; what is clear is that there currently exists a large demand for high power sound systems capable of punching out the throbbing disco beat at levels bordering on the threshold of pain.

It has been generally observed that there seemed to be a lack of hardware — particularly speaker systems — that were optimized for high level playback of disco music. Certainly neither of the two commonly used types of speakers — the home hi-fi speaker or the conventional sound reinforcement setup — was ideally suited for the application.

Hi-fi type speakers proved disastrous in all but very small or relatively quiet installations. Most are low efficiency designs that get into trouble trying to attain 110dB at 1 meter, and when the goal is perhaps 115dB at 5 or 10 meters, it's hardly surprising to find driver units exploding like popcorn! Even the more efficient hi-fi systems are inadequate for large installations, and there are more cost-effective solutions than using them in multiples.

The PA, or sound reinforcement stack has an edge over hi-fi gear in efficiency, power output capability, and ruggedness, but observations are convincing that these, too, have serious shortcomings for disco use. What follows is a discussion of our objections to the conventional fifteen-inch-woofer-plus-high-frequency-horn setup, with descriptions of the solutions to these difficulties that our efforts have evolved.

#### UNDERSTANDING THE DISCO SOUND

##### I. Woofer Crossover

Most reinforcement systems are two-way design using a 500 or 800Hz crossover point. When reproducing disco music with considerably more bass content than typical live material (on top of which some low frequency EQ may be added), the woofer cones are driven well beyond their linear travel region. If harmonic distortion were the only effect, this might be a tolerable situation (in fact it has been shown that harmonic distortion adds to the perceived "richness" of bass notes). Unfortunately, these nonlinearities also generate intermodulation distortion with *midrange* frequencies up to the 500 or 800Hz crossover frequency. The subjective effects of this are *far* from pleasing — a garbling of the sound that naturally gets worse the louder the system is played, and can be intolerable at the high SPL's common in discos.

This assumes, of course, that the power amplifier never gets driven to clipping — a hopeful premise at best. When the amp does clip, intermodulation products are generated in a similar fashion, but tend to be of a higher order nature that is even more grating to the ears.

A practical and very effective solution to this problem is to use a first crossover frequency of 200 or 250Hz, and keep all heavy, long-excision bass information in its own dedicated channel. Then this low frequency amplifier-speaker combination can distort at will without degrading mid-range clarity. Above 200Hz, cone excursions are quite small even at high SPL, so it is much easier to keep the drivers in the linear travel region.

This one measure can improve reproduction quality so dramatically that it is highly recommended as a modification to existing systems lacking clarity and low-end punch. Simply adding some high power bass amplifiers and speakers (we suggest folded horns, for their efficiency) and an electronic crossover at between 150 and 250Hz will revive many an ailing system. Of course, a passive crossover will provide some of the same benefits, but the bi-amplified system is preferable.

## 2. Low Frequency Output

PA gear usually isn't designed to radiate much energy below 70 or 80 Hz, where much of the rhythmic content of disco dance music lies. With high efficiency bass horns backed up by plenty of amplifier power (and corner-loaded in the room wherever possible), response can be extended to below 30Hz, with enough output capability to physically vibrate patrons — a very impressive and sought-after effect. A number of discos around the country have even installed the "Earthquake" Horns developed for use in the film of the same name (see R-e/p, April '75). With enormous power output and response nearly into the subsonic region, the effect defies description.

## 3. High Frequency Response

For PA jobs, high frequency response to 8 or 10kHz is often considered adequate. However, if a record with clean signals up to 15 or 20kHz is played through such a system, quite a bit of the "liveness" and "sparkle" is lost. Since disco speakers seldom have to throw farther than 50 or so feet, (and hence aren't subject to high frequency losses due to long distance projection), it is practical to try for top octave reproduction. The development and use of small horn supertweeter arrays crossed over at 6-8kHz to handle the upper registers are very efficient and project well at these frequencies.

## 4. Midrange Transducers

Cerwin/Vega has for many years been philosophically opposed to the use of compression driver/horn assemblies at lower midrange frequencies (below about 2kHz). Midrange horns have a characteristic "honky" sound, which arises as a combination of several phenomena. One is the distortion generated by the air itself, which is nonlinear under high amplitude pressure waves such as are found in the constricted horn throat. This nonlinearity generates harmonic and IM distortion.

Add to this the problem of diaphragm breakup at high drive levels (especially severe with metal diaphragms), and you have a system that may generate 20 or 30% distortion in the most subjectively critical band of frequencies within the entire audio spectrum.

Since the energy content of music falls off quite rapidly above 2kHz (allowing reduced drive levels), and shorter horns may be used with good pattern control (reducing throat distortion), there is quite a bit to be gained with this 1½ or 2 octave upward shift in crossover frequency.

To handle the 200-2000Hz decade, we have developed a series of highly damped cone drivers in shallow horn enclosures that come within 2 or 3 dB of the sensitivity of the best compression drivers, handle far more power (200 watts for a 12" unit), and have almost perfectly flat response in this range. Since there is no constricted horn throat, there is no throat distortion, and response irregularities and uncontrolled diaphragm breakup are virtually eliminated by special damping compounds applied to the speaker cones. When these drivers are backed with amplifiers with enough headroom, the resulting sound is clean enough that it doesn't offend the ears, even at the 120dB levels found in discos.

Thus, the "ideal" system is four-way, tri-amplified with crossovers at 200-250Hz and 150-2000Hz with an additional pas-

sive crossover at 6-8kHz (though the 150 - 2000Hz crossover may also be passive without sacrificing too much). This system is available packaged in as few as two relatively compact enclosures, one for the bass driver and the other housing



everything else and measuring only 32"H x 24"W x 16"D. (See Fig. 1 for details.) This kind of arrangement is especially attractive because of the flexibility of speaker deployment it allows. The bass horns can be located in corners where they energize the room most efficiently, and the more directional mid-treble cabinets may be suspended around or above the dance floor, aimed for minimum spill into seating and conversation areas. Since stereo effects are almost nonexistent at low frequencies, this separation of the bass speakers from the rest of the system has very little effect on the overall sound — another benefit of a low first crossover frequency.

Of course, not every disco installation can afford to be this elaborate. The establishment may use a disco format only part time, and be unable to justify a large system. Or very high SPL's may not be desired, or the system may have to be portable. For these compromise applications, there exist a variety of one piece, self contained systems which hold, wherever possible, to the philosophy embodied in the large, "full blown" systems.

A good example is shown in Fig. 2. Here, in the interest of compactness, some bass efficiency has been sacrificed, and a combination of front horn and rear reflex loading for the 18" bass driver is used. The system has relatively flat bass response down to about 60Hz, but even at 30Hz it will sustain a 300 watt input with low distortion, so that some of the low end rolloff can be recovered with equalization. At 250Hz, a single horn-loaded 12" driver takes over, and crosses

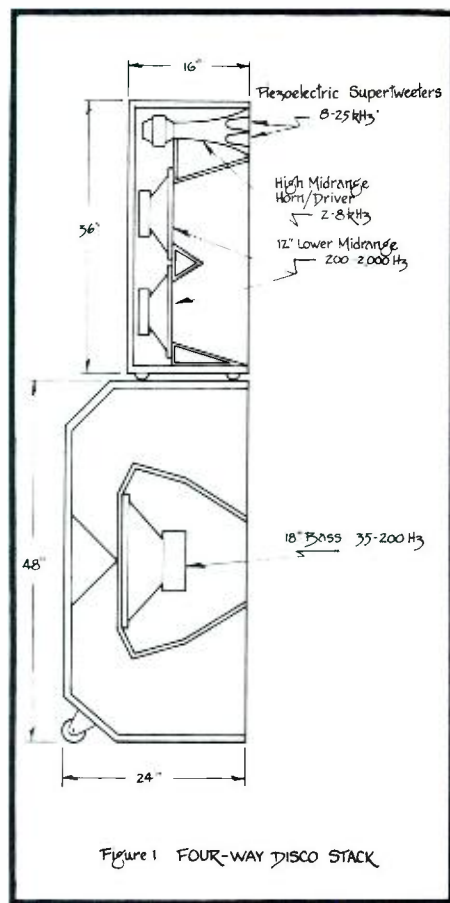


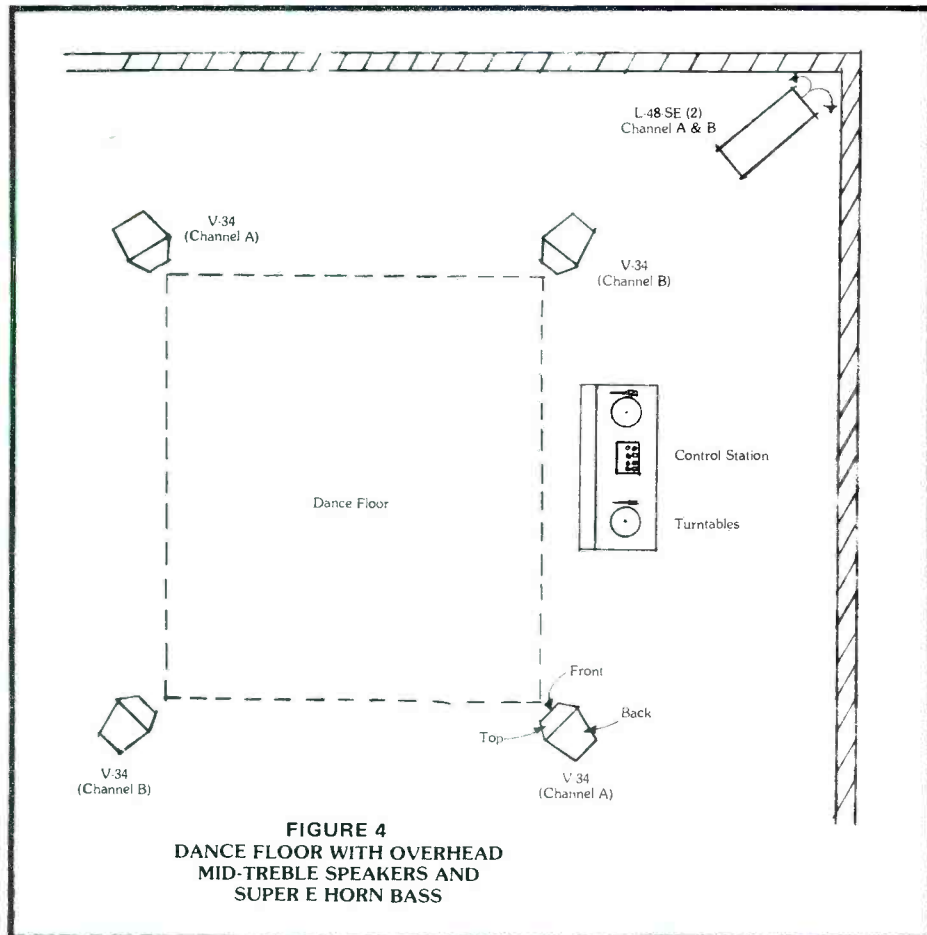
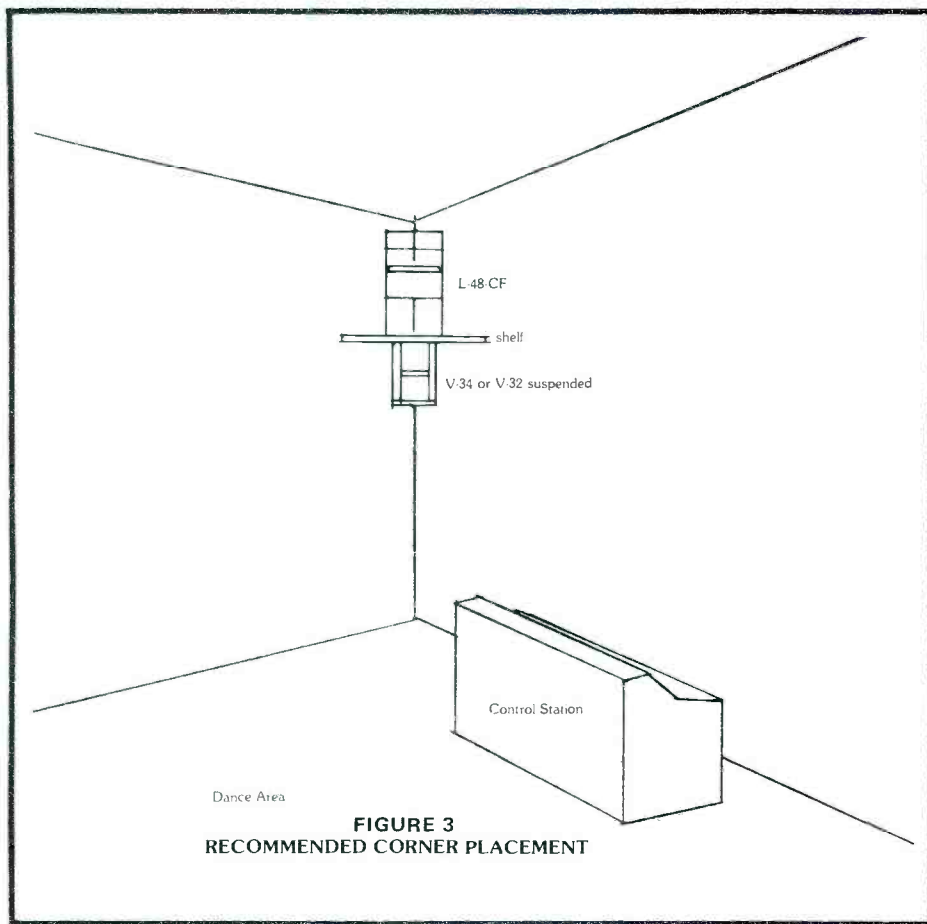
Figure 1 FOUR-WAY DISCO STACK



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over at 4kHz to dual dynamic horn tweeters. The system measures 36"H x 24"W x 24"D and is fitted with casters and handles. Bi-amplification is optional, and attainable SPL's exceed 124dB (@ 1 meter).

If restrictions on size and cost are even tighter, one must be prepared to trade SPL, bass response, or both. Probably the best compromise would be the sturdiest, most efficient studio monitor available that meets the other criteria.

### PLANNING A SYSTEM

Like any sound system, the best time to start planning a disco installation is before the foundation for the building is poured; however, in the real world this is seldom possible. Often, though, a switch-over to a disco format will be accompanied by some degree of remodeling — if so, the sound installer should try to be on the scene before the work actually begins. Whether or not one is stuck with a structure "as is," there are some important things to consider when planning the system. In no particular order:

- As mentioned above, the best place for bass speakers is in a solid room corner. If located where crowds may gather around, the speakers should be four feet or more above floor level. (See Fig. 3).

- The AC power requirements of the system (including any lighting that is contemplated) should be determined and compared with the capacity of existing wiring. Any new wiring should of course comply with applicable building codes.

- "Quiet areas" should be furnished with as much absorptive material as possible. Carpeting on floor, walls, and even ceiling, thick pads on tables, heavy drapes, sound baffles (like in studios), and anything else that will soak up sound will help.

- The disc jockey shouldn't have to sit in the direct blast of the loudspeakers, or it may be impossible to cue records.

- All equipment and interconnecting wires and cables should be protected from tampering, but easily accessible for servicing when necessary.

- Even if it's not specifically called for by the manufacturer, forced air cooling for power amps is an excellent idea. The cooler equipment runs, the greater its life expectancy.

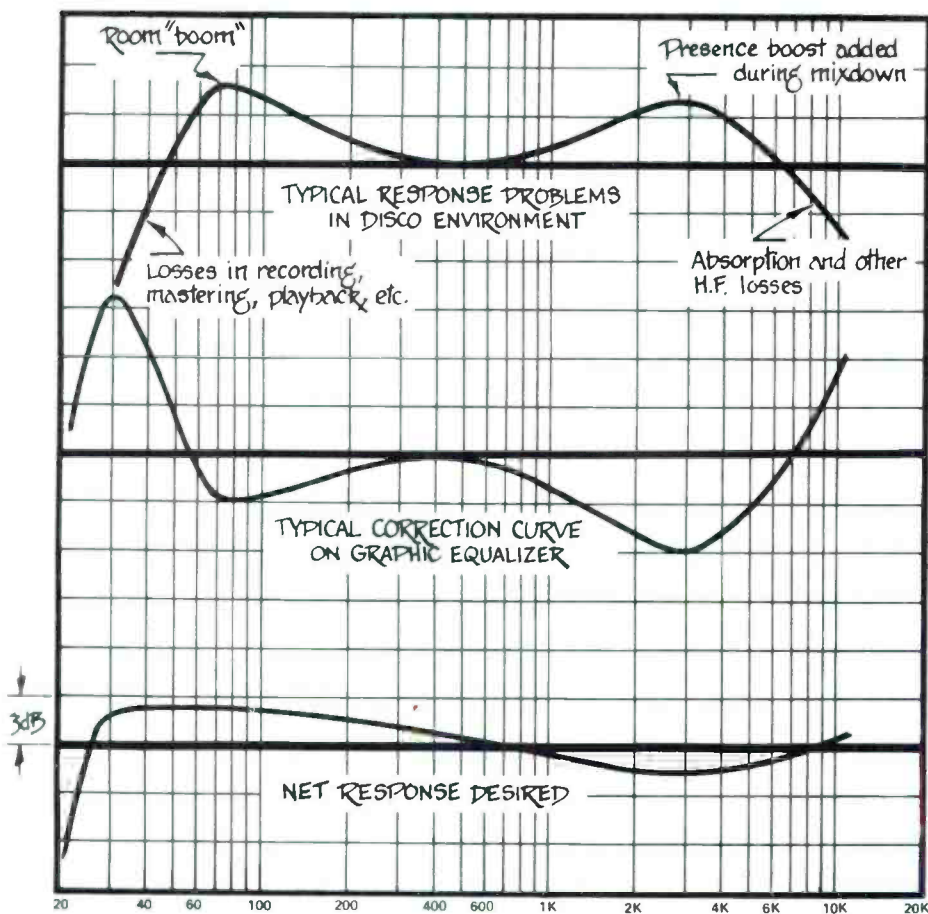
- Until the hardware and software picture changes drastically, there doesn't seem to be much point in going to great extra expense installing four channel systems. The increased distortion and reduced bandwidth and signal-to-noise ratio hardly justify the claimed benefits of quad. Where four speakers are appropriate, we suggest crossfired stereo.

### EQUIPMENT SELECTION

Speakers (See above)

Amplifiers





Matching power amplifiers to loudspeakers in situations where either may be driven to the limits of its capacity is a tricky process, complicated by the fact that speaker manufacturers use varying procedures in arriving at their power ratings. Probably the most meaningful rating is the continuous RMS power spec. but even this doesn't tell the whole story.

The final choice must be a compromise, with enough amplifier power so that most musical peaks go unclipped, but not so much that great danger of speaker damage exists.

The disco installer has another ominous variable to contend with — the operator of the system. In the rare event that some technical competence on his

part can be reliably assumed, it may be safe to amplify each speaker component with its full rated RMS wattage, or even a little more. Otherwise, we suggest derating the speakers to around 60% of their published RMS ratings when picking amplifiers (e.g., 180 watts RMS for a 300 watt speaker, etc.). This allows a fair margin of safety in case the amplifier is grossly overdriven. Some education of the system operator may also be in order, along the lines of "If you can hear any distortion, turn it down." Unfortunately, some people mistake distortion for volume, and will turn up *any* system, no matter how powerful, until it begins to distort audibly. The best solution in such cases is a limiter with the threshold set (and locked!) at some safe power level.

In choosing amplifiers for disco use, fractional zillionth distortion percentages probably aren't as important as things like reliability and serviceability.

#### Mixers

Among the vast array of mixers now on the market, some are designed especially for disco use, and others are adaptable without major modifications. Some particular points to look for would include:

- Inputs: Stereo inputs on a common fader are convenient, but not strictly necessary. Of course, use with record players requires RIAA equalization somewhere in the system.

- Outputs: Stereo, with enough drive capability to drive paralleled power amps or whatever is to be connected.

- Cueing system: A *pre-fader* echo or monitor send with an outboard headphone amp can be used to implement this feature if the board doesn't have it built in.

... continued on page 54

## Magnetic Reference Laboratory

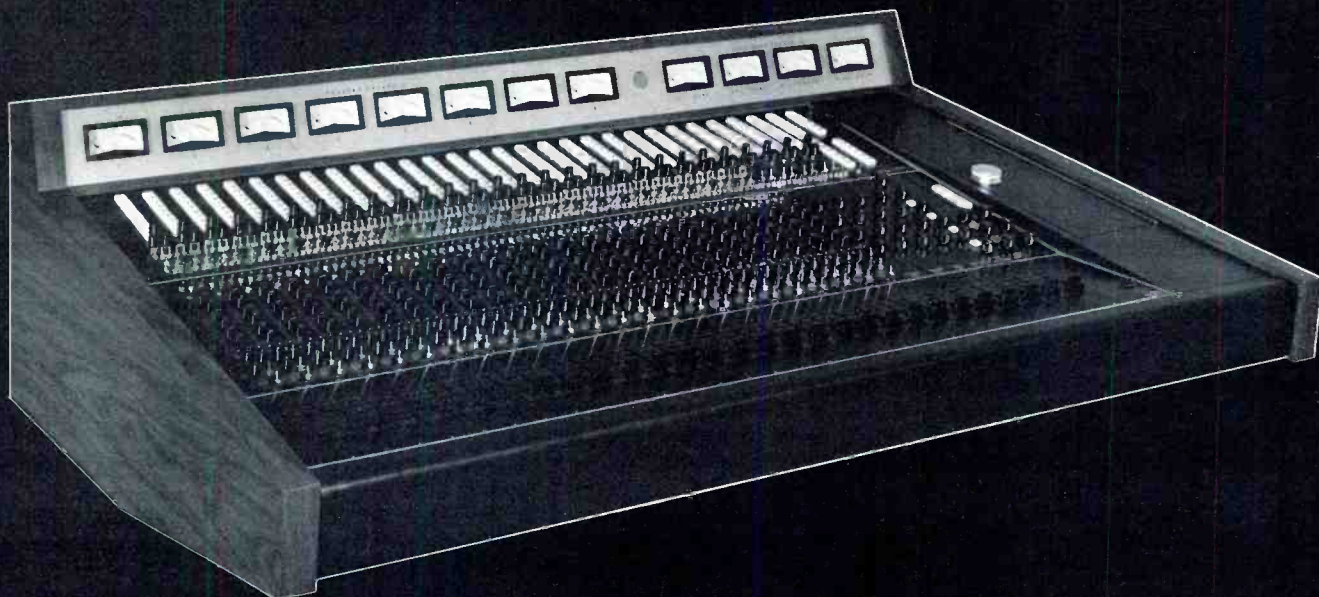
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# ANDY JOHNS TALKS ABOUT OTHERS

## and the 'STONES'

### album 'IT'S ONLY ROCK 'N ROLL'

by  
PAUL LAURENCE

Whatever else you might say about the Rolling Stones, you can't say they haven't tried. I mean, how many groups can even stay together long enough to go through two blonde guitarists, or lose that many lawsuits to Allen Klein? How many other groups would throw a free concert and have *that* happen? Who else has ever had a performance reviewed as "excellent rock & roll, but not decisive"?

And you've got to remember that it hasn't always been this easy for the Rolling Stones. In "the early days," they were so poor that they had to steal eggs at parties and returnable bottles wherever they could to augment a lifestyle that rarely rose above the level of mere subsistence. Home for them was no sanctuary either, as the boys waged a losing battle against their tiny Chelsea flat's singular effort to self-biodegrade, ultimately being driven out of all but the end room by a "Sorcerer's Apprentice"-like army of dripping pipes, rust, mold, peeling paint, and falling plaster. Much later on, when the success of their initial records would bring them to America for their first U.S. tour, they would finish second to a performing horse.

Life for Andy Johns has been a strange sort of experience as well. Born just 25 years ago in Epsom, Surrey (after which the fine table salt is named), he has somehow pulled things together to become one of England's top mixers, perhaps rivalled only by his older and also-legendary brother Glyn. His credits, certainly, are impeccable: Traffic, Free, Jethro Tull, Led Zeppelin, Blind Faith, Joe Cocker, Leon Russell, and Stephen Stills are but some.

As for the new, "Rock 'n Roll" is first and foremost another new recorded/mixed sound for the Stones, in and of itself a tradition<sup>2</sup>. Instrumentally, it features a fuller-than-usual range of effects to create some new and novel textures. Stylistically (and no doubt to a degree the result of these new sounds), it represents the band's initial foray into Gamble & Huff-dom with some Philadelphia-styled jazzy soul.

All in all, the group was pleased. "A step forward," said Keith Richard. The critics (in their own cryptic way) were pleased. "Decadent . . . desperate . . . violent . . . intriguing," said one. Even the fans — those

The Rolling Stones seem to have this thing for Andy too. Although he's very modest about his abilities, they've seen fit to have him be head engineer on their last three albums, recorded in France, Jamaica, and West Germany, respectively.

"It's Only Rock 'n Roll" is, in a manner of speaking, the most recent Rolling Stones album<sup>1</sup>. Like most of their records, it is a mixture of the old and the new. The familiar elements, to be sure, are there in Mick Jagger's urgent vocals, Keith Richard's driving suspended-fourth chording, and Mick Taylor's mercurial guitar flights, supported as usual by Bill Wyman's self-effacing bass and Charlie Watts' eminently tasteful drumming. Joining them on keyboards, as is now the tradition, are three of the era's most respected and distinctive players in Nicky Hopkins, Billy Preston, and the inimitable Ian Stewart. Thus assembled, they explore many familiar Stones highways and byways: the acoustic, country-tinged ballad, the slow gospel number, the Jagger/Richard duet, and, of course, plenty of that chunky and spirited sort of music for which they are so well known.

vast legions of otherwise-normal Americans who just can't seem to get the intro of "Honky Tonk Women" out of their heads — even they were pleased. Released in October of 1974, "It's Only Rock 'n Roll" spent 20 weeks on "Billboard"'s album chart, occupying the No. 1 position for but a week before its sudden and decisive ouster at the hands of Elton John's greatest hits.

Sound-wise, it is the cleanest and most "studio" Rolling Stones album in a long time. This is due to a number of factors, among them being a higher percentage of overdubbed tracks (partially a result of Mick Taylor's being absent for half the album's tunes, forcing Richard to make up the difference), less rumble, and generally tighter miking. Tonally, "Rock 'n Roll" has a very rich and midrange-y sound, fairly unadulterated by leakage (= highs) again because of more overdubbing and tighter miking. The album's sparser instrumentation also contributes to its overall accessibility, there being appreciably fewer tracks per song than is customary, only one tune having "outside" backing vocalists and none with brass or strings. "It's Only Rock 'n Roll" is a much "drier" record than might be expected, having far fewer tape delays than previous albums.

With regard to individual tracks, "Rock 'n Roll"'s key aspects are as follows: the vocals (and this is pretty radical for these guys) are quite clean, of moderate level, and up-front, with not nearly as many per song as in the past. Many of them have a somewhat "breath-y" quality, a result of less limiting/compression than is normal for them. The drums are also "airier" than ever before, due to a greater proportion of overhead to close miking. The kick drum (long a focal point of the Rolling Stones' sound) is here less prominent, having noticeably less limiting/compression as well.

**PAUL LAURENCE:** Was it always your intent to be an engineer?

**ANDY JOHNS:** Yeah. I started hanging out at studios when I was 12 or something when Glyn was working at IBC. It was what I always wanted to do.

My first gig was at Olympic. I remember the first session I ever seconded — it was with "FAMILY" and it was their first session too. Jimmy Miller was producing, John Gilbert was there, Eddie Kramer was engineering . . . God, it was weird. That project took a long time to do, but it really came out all right. I think I worked at Olympic for about eight or nine months, and then they threw me out 'cause I . . .

continued overleaf —

1. Two other albums have been released since, but neither is comprised of current, previously-unreleased material. "Metamorphosis" (Abkco ANA 1) is a collection of old demos and outtakes, while "Made In The Shade" (Rolling Stones CDC 79102) is a "greatest hits" collection spanning 1971-1974.

2. The group has not released an album that sound-wise could be confused with any of its predecessors since "Let It Bleed" in 1969, which fairly closely resembled the previous year's "Beggars Banquet."



"... when I am producing sessions, I don't feel that I am doing anything different than when I am just engineering. I say the same things and do the same things, but at the end of the album they call me the Producer, as well as, or instead of, the Engineer. It really doesn't make much difference."

was always turning up late! Then I went to work at a place named Morgan Studios. I seconded there for about two months or so, and the only other engineer there left for Canada and so I started doing all the sessions. We did some amazing albums that first year. I'd only just started, and I'm working with all these incredible people! Jack Bruce, Traffic, Blind Faith, McCartney used to come in . . .

**PAUL LAURENCE:** Did Glyn teach you many of his techniques?

**ANDY JOHNS:** No, not really. When I was working with Glyn, I wasn't that terribly interested in engineering. I didn't even bother to watch what he was doing, and I never really thought to ask very much.

Certainly, he does have fairly definite ideas, especially about things like drums and vocals. Miking is his trip, really. He just seems to get them in the right places. It's very easy to get a sound on something — it really is — but when you stick all those sounds together, will they all work with each other? Glyn's always do. He's a brilliant balance engineer as well. The

first bunch of years he was working, there wasn't much multitrack stuff done. It was mostly straight to mono, so you had to get it together then and there and get a really great balance. If you get an incredibly good balance on anything, the sounds don't have to be individually that spectacular.

**PL:** Is it true that your brother was one of the first English engineers to close-mike?

**AJ:** Something like that. Glyn started in like 1959, and in those days, everyone was still into recording with distant mikes. The mikes would always be like four or five feet away from everything. I think rock & roll was pretty much done that way too. If you listen to those old rock & roll records, there's not really much separation — you can hear the drums leaking all around the room. I think that Glyn was one of the first people to get into screening everything off and close-miking it for a tighter sound, and to go for a definite "sqund" on an instrument.

**PL:** Do you have any specific beliefs about what an engineer should be or do?

**AJ:** I suppose if I do, it would be in the way that you work with the people, more than any specific ideas about how something should sound or something. I just try to lay it out so that the session goes smoothly and nobody gets hung up. You're sort of sequencing everyone properly, and trying to keep them fairly cooled out. Like if the drummer wants to do a drum overdub or something, and everyone else goes "Oh no, man, come on!" you try to tell the guy in a way he'll understand, or let him do it for one time and have him come in and see for himself that it doesn't work.

**PL:** Now you're pretty much talking about "producing," aren't you?

**AJ:** The two things are so closely related. The idea of "producer" and "producing" is very strange anyway. When I am producing sessions, I don't feel I'm doing anything different than when I'm just engineering. I say the same thing and do the same thing, but at the end of the album they call me the producer as well as or instead of the engineer. It really doesn't make much difference.

**PL:** Have you ever had any engineers or producers whom you thought were excellent, and wanted to be something like? Who's your idea of a great engineer?

**AJ:** I'm not really too into that. Sometimes, I do listen to records and go "Blimey," and I want to give up.

**PL:** What sort of record makes you feel this way?

**AJ:** Just something that has a fantastic sound to it. What first turned me on to wanting to get good sounds and things was that "Buffalo Springfield Again" album, which I thought was fantastic! Botnick did most of that, didn't he? I've met him once or twice. Hendrix's first album was another record that had great sound. I don't have any specific favorite engineers, just individual albums with good sound.

**PL:** When did you first work with the Stones?

**AJ:** I seconded a lot of their sessions on "Satanic Majesties." I used to see Mick around quite a bit at that time because he was producing a few people for Andrew Oldham — Chris Farlow, Pat Arnold — and he was always kind of floating in and out of Olympic. I also knew Bill fairly well.

The first thing I ever really did for them would have been "Little Queenie." I was doing a session at Olympic for George Harrison, and Mick turns up with these tapes and says "Ah, great. Can you mix this business?" I ended up by doing one or two mixes for the "Ya-Ya's" album, also the sequencing and the audience overdubs and all that.

It was really scary working with them to start with. They were very much into being right on top of you, but I somehow managed to get away from that after not too long. It's just that they didn't trust you very much to start with — they didn't trust anyone very much to start with. As soon as they found out you were okay, they would leave you alone completely.

I should tell you about the first actual session I ever did with them. It was at Stargroves with the truck, and this was the first time it had ever been used. They had been working on "Bitch" all night, and I'd been working on the sound. We'd reached this point, and so I called everybody in for a playback. Everyone who was at the house — all the hangers-on, groupies, and everyone — crammed into the truck to have a listen. After a bit, Mick turns around and goes "What the hell do you think that's supposed to be, Andrew? I could do better on my bloody cassette!" This is in front of all these people! I thought "Well, I can't let him get away with that," and I said "No, man, I think it sounds quite good meself. Sounds perfectly all right to me. Perhaps we should talk about it outside." He said "There's nothing to talk about — you just get it together." I played it for him the next day and he thought it was fine.

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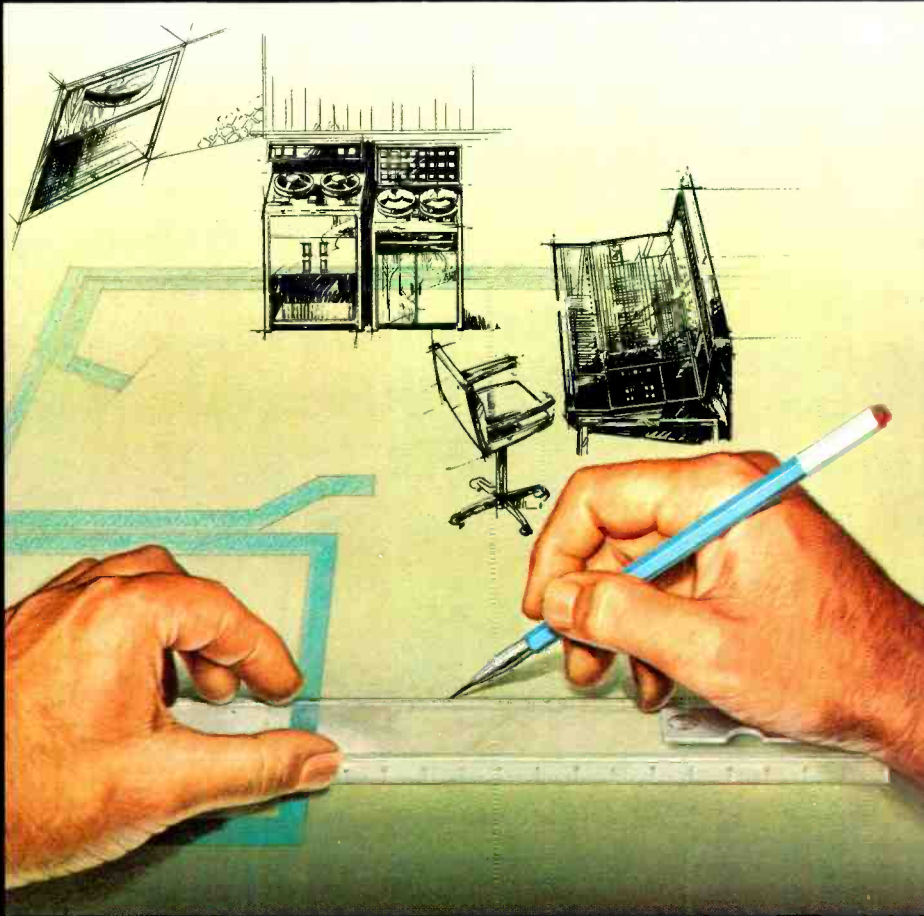
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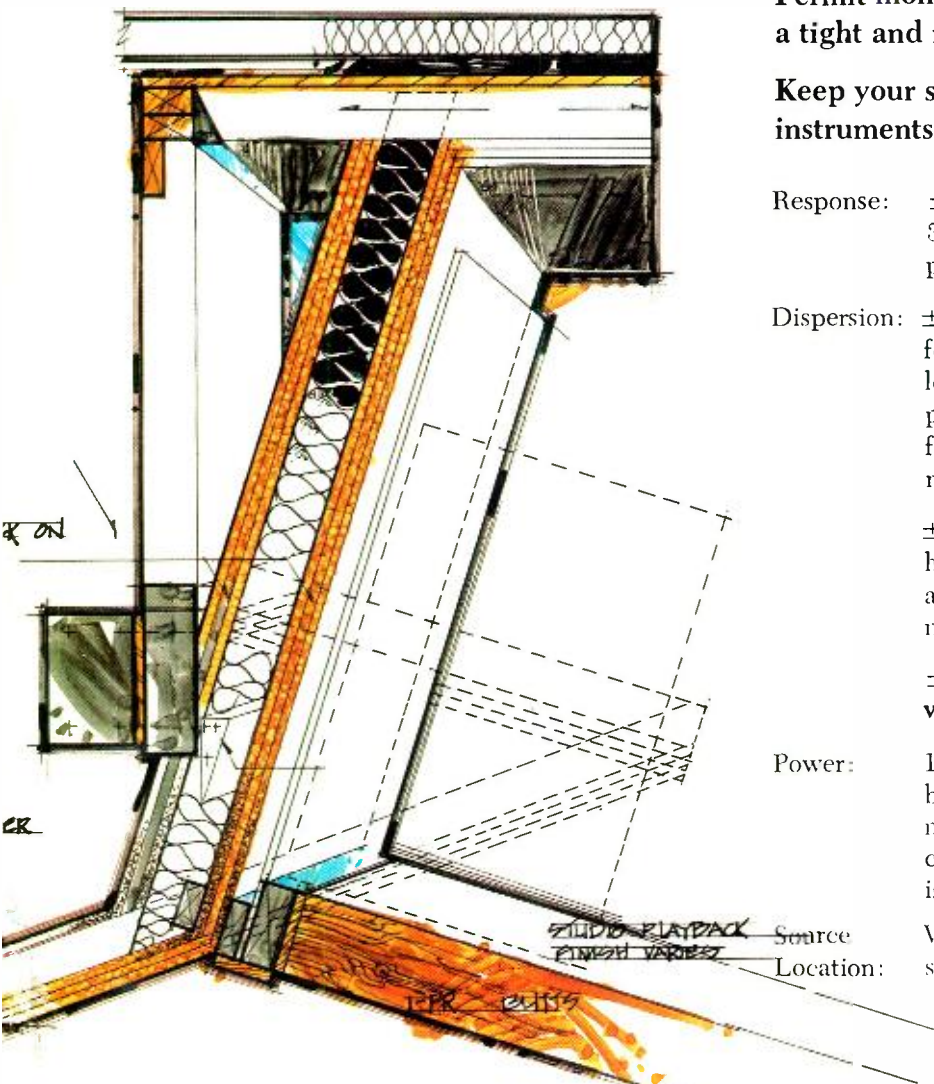
Dispersion:  $\pm 2$  dB @ 10 KHz across a minimum 10 foot horizontal plane at the console (from left of the engineer to the right of the producer or vice versa) from any one of the four monitors, measured with pink noise source.

$\pm 2$  dB @ 10 KHz across a minimum 10 foot horizontal plane front to back in the mixing area from any one of the four monitors, measured with pink noise source.

$\pm 2$  dB @ 10 kHz from 6" above console vertically to 6" down from ceiling.

Power: 116 dB SPL minimum, linear scale, with broadband pink noise source from one monitor measured at the mixer's ear. The control room potential with four monitors is a minimum of 128 dB SPL.

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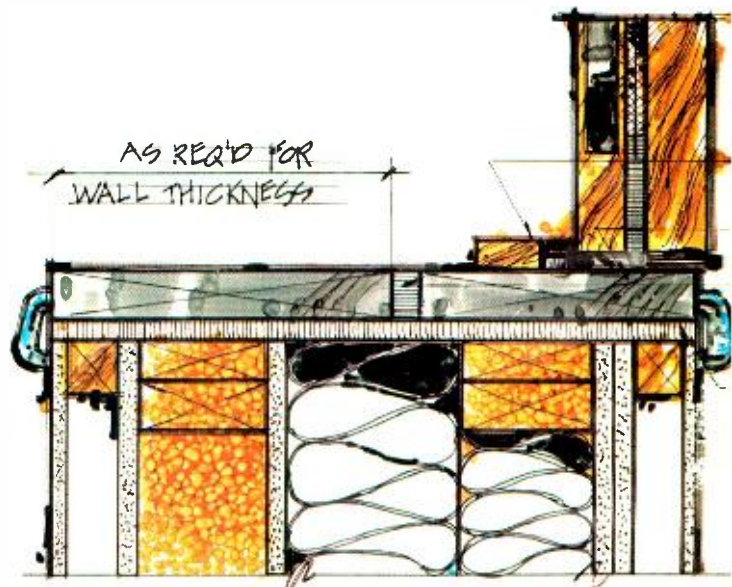
Room Character: The characteristic “room sound” which results from recording in a three dimensional area is eliminated by the utilization of an active ceiling. From 40 Hz up, this produces an infinite third dimension such as would be present in an amphitheater.

Separation: Active traps are built into the studio walls which allows “in-studio” vocals, eliminating the need for the usual vocal booth. 30 dB of isolation can be provided between the band and a vocalist only 10 feet away, resulting in 30 dB of isolation @ 40 Hz or tuned frequencies.

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**SYSTEM PERFORMANCE ACCEPTANCE**

In accordance with the terms set forth in that certain agreement contained within Westlake Audio's invoice number 3930 dated March 1, 1974 mutually accepted by Westlake Audio, Inc. and Sounds Interchange, the undersigned hereby:

1. Acknowledges receipt of and accepts a final sound measurement report from Westlake Audio, Inc.
2. Agrees that Westlake Audio has, as relates to the design and construction of the Sounds Interchange studio facility, Toronto, Canada, it met or exceeded all performance specifications as set forth in the Westlake Audio brochure entitled Acoustical Design The Key To The Success Of Your Studio as amended and signed by T. L. Hidley on February 8, 1974.
3. Acknowledges that all work has been completed in a satisfactory manner and that all materials have been delivered.
4. Acknowledges the fact that Westlake Audio, Inc. has complied with and fulfilled all the terms set forth in a certain Letter of Credit drawn in favor of Westlake Audio, Inc. and hereby instructs the advising bank — Bank of America, Westlake Boulevard, Westlake Village, California, U.S.A. to honor and pay at sight said Letter of Credit on or after December 6, 1974.

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continued from page 34

PL: You limit the guitars a lot, don't you?

AJ: I used to. I used to compress things a lot of the time. I don't very much anymore.

**AIN'T TOO PROUD TO BEG**

AJ: This is Billy on clavinet, overdubbed. It's going through a wah-wah, very compressed, with lots of midrange. I think we took it mike and direct.

PL: Are there any original vocals on this album?

AJ: I don't think so. Mick doesn't very often sing much for the cans because they go on for so long doing a track that after four or five hours, he's getting a bit bored with it, and so he'll maybe just do the ends of verses and the ends of choruses so they know where they are.

PL: Is Mick an easy vocalist to record?

AJ: Oh yes, he's very easy. We generally record him pretty flat — maybe just a notch of top or something, or a notch of bass out.

PL: How many takes does he normally go through before he gets a vocal to his liking?

AJ: Not very many. Usually he'll run through it a few times, do three or four takes, and then maybe drop in a verse. If it's not happening, he'll just stop and say "Let's do it another night."

**IT'S ONLY ROCK 'N ROLL**

AJ: I wasn't in on this one. It was done over at Ron Wood's studio when they were doing his album. This isn't the Stones rhythm section — it's Kenny Jones on drums and Willy Weeks on bass.

PL: What would you have done differently had you been involved?

AJ: I don't know, the rhythm section just doesn't mix on this. I certainly would have mixed it differently. The drum sound's a bit funny on this as well, don't you think?

PL: Is that fuzz guitar coming straight into the board?

AJ: Sounds more like the amp breaking up to me. Maybe a little compression in there too.

**TILL THE NEXT GOODBYE**

AJ: That's Keith on the first acoustic — which is stereo, incidentally — and bottleneck. That might even be Mick Taylor on the other acoustic guitar.

PL: This is a pretty nowhere drum sound.

AJ: Well like I said, I don't know what happened when they mixed the album, I really don't. They did some very strange things.

PL: What is your attitude toward the Stones' fabled "original vocal leakage," like here or "Angie"?

AJ: It doesn't really bother me, but that's just

with them. With another band — supposing for instance "Hide Your Love" — it just wouldn't work. It would just sound awful. We could have said "Well let's re-do the piano that the vocal's leaking onto," and probably could have done it and gotten away with it, but the whole feel would have gone. With the Stones, that's the whole thing — the feeling that they're creating. If you listen to any of their records, that's what it is. Sometimes Keith has tried to re-do his original rhythm part, and it's never come off with the same feel as the basic track.

**TIME WAITS FOR NO ONE**

AJ: This doesn't ring a bell at all. I don't think I did this one.

PL: How would you guess these guitars are being modified?

AJ: Well there's some tremelo on this one guitar, and I would say that the solo is just regular recording with straight old delay echo on it.

PL: Would you say that you did less limiting on this album than you usually do?

AJ: Probably less, yes. It's because the tracks are less frantic and you don't have to compress, say, the vocals so much to come through.

**LUXURY**

AJ: I didn't do this one. Strange sound, isn't it?

**DANCE LITTLE SISTER**

AJ: I didn't do this one either. I hate this one.

PL: I can't believe that Mick Taylor would have approved his track here for the master take.

AJ: By that time, he probably didn't care. I don't blame him either. It's a shitty old track.

PL: Would you say that you used more overhead on the drums on this record than you have in past years?

AJ: Possibly. I used a Sennheiser shotgun mike very, very high over the snare that sounded real good. I had about ten mikes set up for the drums, but was only using four or five at once. I'd keep using different combinations to see what sounded best.

**IF YOU REALLY WANT TO BE MY FRIEND**

AJ: Now this one I did. The basic track was just piano, bass, drums, and guitar. They like to do the keyboard with the basic track if they can. Sounds like Mick Taylor's guitar is going through a synthesizer or an octave divider or something like that. Keith is playing the Leslie guitar. I remember that for the solo — which was overdubbed — we ran Mick Taylor's guitar through a Leslie as well. The bass is Bill.

PL: How about the backing vocalists?

AJ: I don't know, I didn't do them. They were overdubbed somewhere.

**SHORT AND CURLIES**

AG: I did this, unfortunately.

They first started muckin' around with it in Jamaica, but it was actually cut at Olympic. We don't have to listen to this one, do we?

**FINGERPRINT FILE**

AJ: This main rhythm guitar here is Jagger. It's going through a Leslie and mixed stereo.

PL: Isn't there some phasing in there too?

AJ: A Leslie will do that when there's a lot of distortion on it. A Leslie speaker is very similar

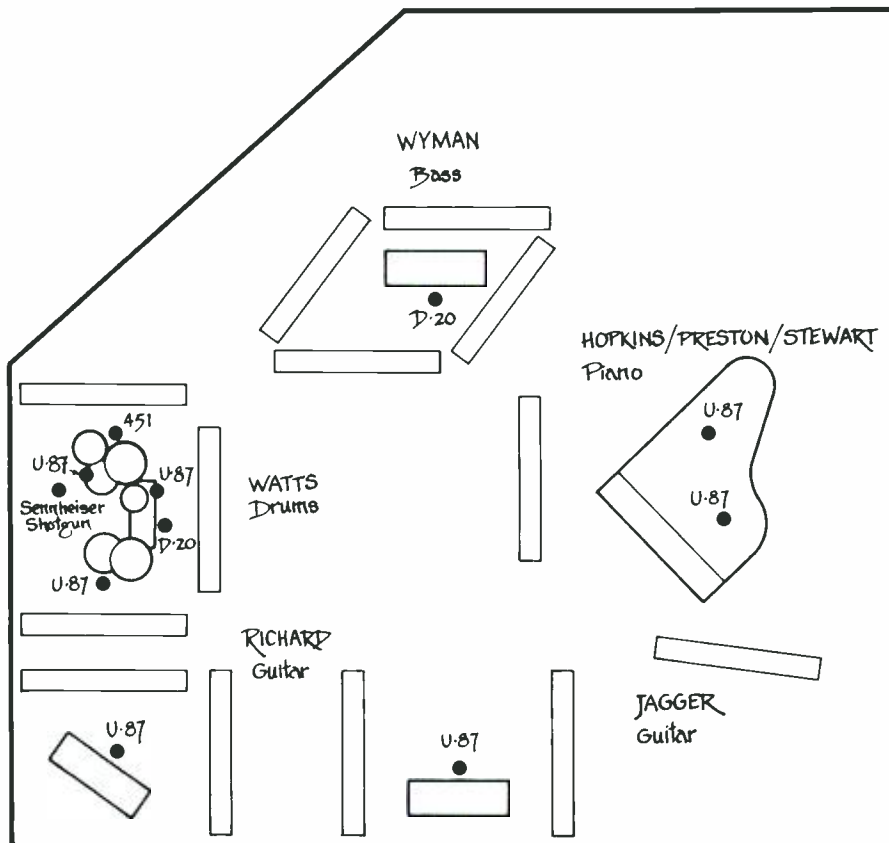


Figure 1 STUDIO SETUP FOR "It's Only Rock 'n Roll" LP (Musikband Studios, Munich)

to phasing because it's changing the phase angles on the sound all the time. It's just a physical means of doing it, rather than electronic. When you get a lot of distortion on something that's going through a Leslie, it's exactly the same sound as a phasing trip.

PL: What kind of guitar does Jagger play?

AJ: He usually plays a Gibson. A black Les Paul. This is Mick Taylor on bass, probably all direct.

PL: Kepexed?

AJ: Doubt it. Americans are into Kepexing a lot, but I don't know anyone else who is.

PL: What kind of buss does Mick Taylor play? He consistently gets a treblier sound than the others.

AJ: He just uses one of Bill's, actually. It's because he plays it like a guitar — he plays pretty close to the bridge and hits it in the same way as he would a guitar. He's a guitar player, not a bass player.

PL: How is it that Glyn came to mix this tune?

AJ: I expect maybe Mick just thought "Oh, Glyn'd really be able to do this one good" and phoned him up.

PL: What is a mixing session for the Stones like?

AJ: Pretty intense. When I first started mixing with them — which was on "Sticky Fingers" — I remember getting off a plane and going straight to the studio one time. I'd been up for like two days, and I went straight to the studio

and mixed three tracks in four hours. "Dead Flowers" was one of them, "Wild Horses" was another. Later on, when we got into 16-track, things became much slower. I remember we had to work very hard to make it sound anywhere close to good with "Exile."

PL: Who would participate in the mixing?

AJ: Keith would usually kind of sit there without saying very much, and Mick would be wandering in and out. He would maybe stay for a half hour, then wander out, and then wander back in again. "No, I want the vocals to be like this. They've got to be like this." Then you'd try them like that, and he would come back in later to hear what you'd done. They're fairly easy to mix with, because they're not terribly specific. They just let you work on it until you say "Okay, I'm happy with the overall sound. What ideas do you have now?"

PL: Would they make a distinction between, say, "reverb" and "delay"?

AJ: Mick might. He's the only one who really gets in on the mixing. Mick Taylor used to come around, but the lead guitar always ended up by being too loud, and so they asked him to leave. During "Exile," I remember Keith turning around one day and going "Listen, man, you're great on stage, but you're awful in the studio. Can you just go away for a bit?" I disagree with that, myself. Mick Taylor never played anything that I disliked and thought shouldn't be there. Whenever he played, I always got a rush.

PL: How many different delay speeds do you use? Will you use whatever's available, or do you usually have a definite speed in mind?

AJ: A bit of both, I guess. An Ampex at 15 is one we use a lot, and I've always thought of it as a definite thing, myself. We used Studers — which have roughly the same head gap as Ampex — for the mixes of "Exile on Main St." and "Goats Head Soup." Another one we've used is the 3M delay, at 15. The 3M has got a very different sort of block, with one head facing this way and one head facing that way, and so you get a longer delay time. We used that, if I recall, on Mick Taylor's guitar on "Shine a Light."

PL: How about "Shake Your Hips"?

AJ: That was an Ampex 440 at 15 ips. I remember, it's that old machine in the reduction room at Olympic.

PL: Did you ever use any non-standard or VSOed intervals?

AJ: Yes, if I'm using it as just a tape repeat, not for driving the plate. We would sometimes use VSOing to get it in time with the song. I think we used an odd speed on "Rocks Off" — the second rhythm guitar.

PL: What do you perceive as Jimmy's contributions to the whole Rolling Stones process?

AJ: One of his trips, certainly, is drums. He's such a great percussionist himself that he was always coming up with good ideas for the drums — for sound and for what the guy should play. He really influenced Charlie's playing on a lot of Stones things. Something like "Honky Tonk Women" — that really sounds to me like a Jimmy Miller trip. I wasn't at that particular session, but from listening to it I'm pretty sure that he had a lot to do with those drums.

Another thing about Jimmy, he had the capacity for remembering which were the best out of like 300 takes! You could do a track for

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three days, and he'd say "Oh, let's hear that fifth one on reel three from the first day, and then the second one on reel six from day two, and then we'll listen to the one we've just done and see which one's the best."

You're not uptight with him at all. When I first started doing sessions, I was only a kid and here I was working with Jimmy and Traffic and those kind of people, and I was well paranoid and scared stiff! With Jimmy, you felt that if you didn't get it right immediately, it was okay because he was quite sure that you would in the end. If you made a mistake, he'd say "That's okay, man, don't worry about it." He was great like that. He just made you feel good, and so you ended up getting it together.

**JIMMY MILLER ALIVE and WELL**



Producer Jimmy Miller, rumored to have died under bizarre circumstances in England earlier this summer, it seems is quite alive and living in the hills above Los Angeles. When asked, recently, for some irrefutable proof of his continued existence, so as to convince any skeptics, he replied, "I'm building a pool, aren't I."

*PL: Just out of interest, what do you think of the "Blind Faith" record?*

AJ: I think it's a great album. It was done in a rather funny sort of way, though. I did that one at Olympic, where Stevie sings "Come down off your tree . . ." and all that stuff. "Can't Find My Way Home" — that's the one. God,

that was a weird session! We did that whole thing on two mikes. Eric's playing like a big lute — an 8-string lute — and Stevie's playing like a small nylon string acoustic guitar. We put a mike in front of each guitar, and Ginger and Rick were just picked up from those two mikes.

*PL: How many tracks of tape have the Stones used since you've been working with them?*

AJ: Let's see . . . "Satanic Majesties" was 4-track, "Beggars Banquet" was 4-track, "Let It Bleed" was 8-track, as was "Sticky Fingers," I think. We never worked 16-track till "Exile on Main St."

*PL: So you mean all those great drum sounds were live-mixed to two tracks, with the bass drum going to both sides?*

AJ: Sure, man. Most of the best sounds were done on 4-track, actually. I was listening to "She Comes in Colors" yesterday on the radio, and there's so much stuff on that.

A lot of those 4-track mixes you couldn't possibly have done if you were using 16-track tape. For instance, on "She Comes in Colors," it's drums, bass, one acoustic, an electric guitar?, a piano, strings, background vocals, horns, and there's a lead vocal, and then there's an ad-lib vocal as well. That's 10 tracks! I think we went 4-to-4-to-4 to get it all in there. The advantage in doing it that way was that you really only had half the stuff to worry about, and so you could get into all sorts of little trips that you just wouldn't be able to do when you've got 16 things going at once.

Nowadays, you'll have your basic track and say "Well, that's pretty good. We can always double-track that rhythm guitar, and maybe drop the bass a little where it goes . . ." In

those days, the basic track had to be *incredible*, and really turn you on without any overdubs or anything.

*PL: To pursue the drums thing a bit further, you've gotten so many terrific drum sounds . . . Could I possibly inveigle you into remembering what you did on "Sway," for example?*

AJ: Yeah, I remember that pretty good. I got the impression that probably no one else ever would, but I like the sound on that track too. That was a great track.

I'll tell you all this stuff because it's interesting for me to remember, and I'd love people to be interested, but I don't want them to think that I'm saying "For this exact sound, do this." I mean, you can take a drummer into the studio and do exactly what I did, and it might not sound anything like "Sway"! You might have to do something entirely different to get that sound.

A lot of the drum sound on "Sway" has to do with the overhead mike and how it's equalized. We put it right over the snare, and that's where most of the snare sound comes from. With Charlie, I always used to have to add a lot of 2K to the overhead. Really, I think I've done that on most of the things I've ever done with him.

*PL: Why is that? Is it the way he plays? The sound of his heads?*

AJ: Probably a bit of both. I remember on this one that I *did* spend a lot of time on the drums. Also, I got him to tune his snare differently — it's tuned very low.

*PL: What did you do for the drum sound on "When the Levee Breaks"?*

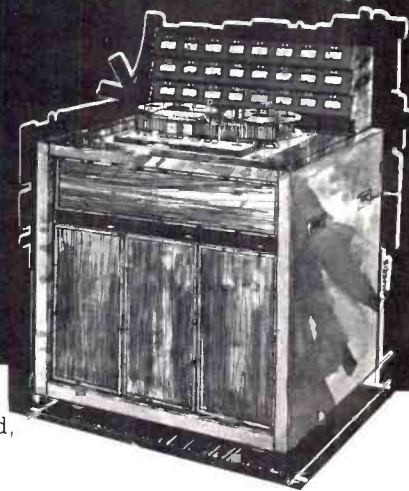
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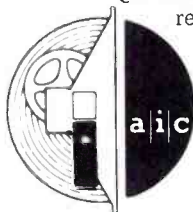
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sound like this,” and so you try to get as close to the sound you hear them making as you can. Their records are just an attempt to get what they sound like in a real situation. I mean, John Bonham gets such a great sound in the studio. He’s got the loudest kick drum I’ve ever heard – an incredibly loud, fantastic sound. It’s like someone shooting a gun! With any drummer who’s that amazing, you can’t get any mikes too close to his snare or you won’t be able to get that monstrous sound. With him, I used to put a directional mike over his shoulder and just aim it at the snare, and use it in conjunction with the overhead. He’s terrific, he really is.

Ginger Baker was actually the first guy who taught me about the dynamics of drums. With all the people I’d worked with before – which wasn’t that vast an amount – it had been “Let’s get a drum sound.” Ginger said “Here’s my sound. Get it.” Not quite as heavy as that, but along those lines. I remember – I was so naive in those days – I suggested doing something to his bass drum one time, and he got a bit upset! I learned quite a bit from Ginger, actually.

*PL: How about John Paul Jones? Is that pretty much how he sounds out in the studio?*

AJ: Yeah. Even though he’s got a big sound, he plays very, very cleanly. I used to put him on two tracks – one miked and one direct. Being a studio musician for so long, he was quite conscious of what was going on with his sound. He’d often say “Let’s have a little more of the direct” or whatever.

Bass is a very difficult instrument to record. With guitar, if you’re not getting a good sound, you can say “Well, let’s try another guitar,” and maybe for that number the guy changes from a Gibson to a Strat and you’ve solved your problem. Or you can change the amp, or

change the mike, or run the guitar through a Leslie speaker and you’ll be getting somewhere. With bass, if the sound’s not right, you don’t have as many options. You can change the mike, but most studios will have only two or three types of mikes that are going to work on the bass. You can change the sound on the amp a bit, probably not too much, though, because the guy won’t want a sound that’s radically different from the one he usually gets. Sometimes you’ll go through a whole day where you just cannot get a bass sound.

*PL: Why do you think this is? Is it the way he’s playing? Humidity? Is it something mystical?*

AJ: It’s something pretty mystical, I really think. You can walk in one day and get a terrible sound with a setup, and walk in the next day – nothing’s different – and you get a fantastic sound. Or you can go through all these changes on the bass and go “Yes, that’s much better,” and the next day you’ll listen to the first take you did and then a take you did four hours later when you’d done all this supposed “work” on the bass, and they sound exactly the same!

*PL: You’ve recorded so many fine guitarists that I thought it would be interesting to compare their approaches and techniques in the studio. How about Jimmy Page?*

AJ: Well, he plays fairly loud in the studio, but you won’t have any serious leakage problems with him because he gets a fairly contained kind of sound. With Zeppelin in general, because there are only three pieces and because Bonzo and JPJ play equally loud, you don’t have separation problems. Pagey pretty much runs the band as far as the recording goes, and

he usually has a pretty definite idea of what he wants to hear.

*PL: Just how engineering-oriented is he?*

AJ: He knows the things that can be done – move the mikes around, re-EQ, turn down. He might do something like specify what kind of delay he’d like and say “I want a 7½ on this.” He’s into that sort of stuff.

*PL: Do you consider him a skillful producer?*

AJ: Oh yeah, I think he’s very good.

*PL: He often punches in on his solos, doesn’t he?*

AJ: Yeah, he does that a lot. I was surprised when I first started working with them, because I figured he’d just sail through the guitar things, but he doesn’t. He really works on them. I think that a couple times he had hassles doing a solo – where he just couldn’t come up with any good ideas or whatever – and so he took a rough mix of the song home and practiced to it. He’s often quite meticulous. I really like working with Pagey. If you’ve got an idea, he’ll always listen, and if it’s a good one, he’ll use it.

*PL: What would be an example of one of your good ideas?*

AJ: “Stairway to Heaven.” He came into the studio and said “I’ve got this great song and it’s going to build a lot.” He works a lot that way. Often he’ll have a concept for a track that will have three or four different sections. I helped with the middle part – the 12-strings and where they came in.

*PL: How about the solo? Basically, what take was it?*

AJ: I couldn’t tell you, really. It would be quite a few, I’d imagine, as he took a long time doing it. We had been punching in a lot, so it could have taken two or three hours to get it all together. As far as the sound goes, it’s obviously compressed, bit of top, bit of midrange, and probably the same again when it was mixed. I remember he was quite pleased with it when we were done.

*PL: How about Mick Taylor? How does he record?*

AJ: Well, Mick Taylor always plays incredibly loud. That’s how he gets all of that sustain. It’s not just for tone alone – he likes that level as well. Because he does play so loud, you have to screen him off a lot. You tend to have him the furthest out of all the musicians, sort of on the outside. More than just level, he has a very penetrating sound. He also has a lot of bottom end, which you don’t really notice so much when you’re listening to him with the other instruments. It goes around the room like mad, though, and we often have trouble with it coming in through the drums or the piano. This happens even when he’s using a Tele, which is a bit surprising.

As far as his equipment goes, he usually uses Fender amps, like a Twin Reverb or something. He also has one of those little Fender Leslies. When we had 16 tracks, I’d often take two channels of him – one the amp and one the Leslie – and send them to opposite sides in the mix. As a general rule, he doesn’t use a lot of effects in the studio. If they’re about, you can ask him to use them and he’ll give it a try, but he’s not totally into it.

It’s really great to work with Pagey and Mick Taylor and people like that. They’re so good that they’ll turn you on every time. Just



listen to Mick on something like "Stop Breaking Down" — he's about the best white bottleneck player there is! That's what I really like about it — not the "engineering" as much as working with people who really bring out the best in you. You hear this music coming through and you can't let 'em down — you've got to try to get the best sound possible because it's turning you on so much!

*PL: How would Mick Taylor talk to you about his sound? Would he say "It's too strident" or "too close-miked"?*

AJ: No, he wouldn't say anything like that. He would always be fairly unimpressed with his sound as a rule. One I remember that he *did* like was "Hide Your Love" — he was well impressed with that. We took it in fairly hot with lots of leakage. That's what he likes.

*PL: Is it true that the solo on "Winter" was done live?*

AJ: Yes. Amazing, isn't it? He would quite often play solos on the track, and they came out that good quite regularly. It's not like that was a coincidence — you know, he'll do it every time!

*PL: Did he seem particularly happy with that solo?*

AJ: He never mentioned anything about it. I used to flip out about it and tell him how great it was, but he never responded in any way. He's very humble in some ways, and not at all in others. He'll do things like want to overdub bass on something that Bill has already played on — which isn't terribly humble — and then on the other hand, you'll tell him what an amazing guitar player he is and he won't say

anything at all.

*PL: What did you do for the sound?*

AJ: Most of that is because there's a lot of leakage. Probably added some midrange and a bit of top.

*PL: How does Keith Richard record?*

AJ: Well, Keith is always a bit of a challenge to record because he drives his equipment so hard. You know, everyone else will be coming in for playbacks, but he won't — he'll still be out there playing! With him, I'm always a bit worried that there's too much crackle-y kind of distortion, as opposed to harmonic-type distortion. It might sound quite good in the room, but you put a microphone on it and it sounds different. His sound is always real big in the studio, but when you mike it, it loses a lot of its size.

*PL: Are there any things in particular that you've learned to do to get the best recorded sound on him?*

AJ: You don't get the impression that Keith is into it very much, but he really knows quite a lot about his equipment. I've picked up a lot of things from him and from working with him.

Mike position is especially important with Keith. Sometimes, for example, if Charlie's not getting the part together properly and Keith wants to really communicate with him, he'll bring his amp over and point it right into the drums. Now this presents all sorts of miking problems, but luckily, with them you'll have plenty of time to experiment with the miking where you really couldn't with a group that only runs a song through a few times before they start doing takes.

*PL: How particular is he about his recorded sound?*

AJ: Not extremely, I would say. He doesn't usually say very much about the guitar sound unless it's really terrible, and then he'll point that out. Sometimes they'll do a take and Keith will say "That's a great take. Maybe we'll use that," and I'll say "But the sound on that guitar's so bad, Keith," and he'll go "Oh, it's all right."

*PL: What would be an example of a master take where that happened?*

AJ: Several things from "Exile." "Tumbling Dice" probably would have been one . . . maybe "Rocks Off" as well, but that came out all right in the end.

*PL: Whatever happened, the guitars on "Rocks Off" have a much tighter sound than most of the other tunes.*

AJ: That's the thing I was saying earlier on about bass sounds. On "Rocks Off," we'd been getting a terrible guitar sound all the time, but that one particular day — I didn't change anything, they didn't seem to change anything — the sound was that much better.

*PL: What sorts of things would Keith say if he wanted a different guitar sound?*

AJ: He might say something like "Compress it" or "Add some more top," but that isn't what he means, really. He means *do* something to it!

*PL: Were you there for the "Sympathy" solo?*

AJ: No. I don't know too much about that one, really. Sounds like Eddie Kramer freaking out with the equalization to me.

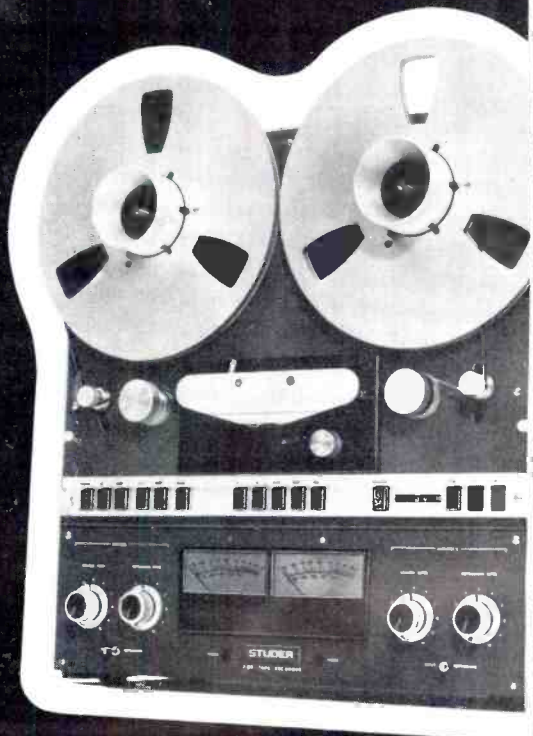
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# SPECTRUM ANALYSIS

## IN THE RECORDING STUDIO

**T**hough spectrum analysis has been used for some time in the lab in high frequency applications its use as a production tool in a recording studio is quite new. New techniques are often surrounded by mystery — spectrum analysis is no exception. This article will attempt to explain some of the techniques, applications and hardware.

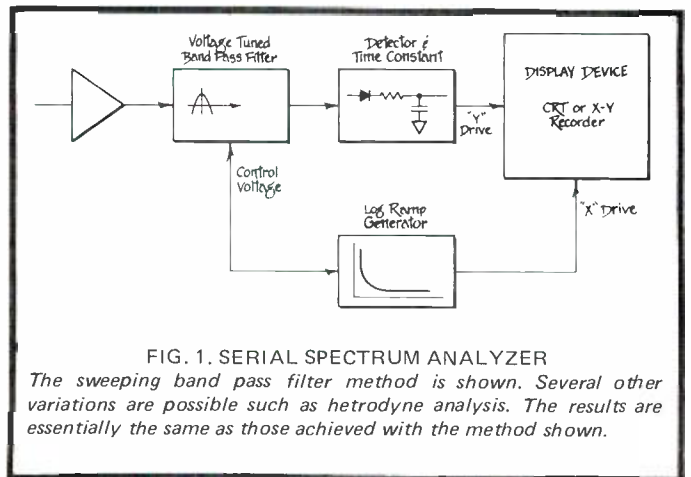
This discussion will confine itself to "real time" analyzers used in professional audio applications. Non real time analyzers were recently covered in an article in the June issue of *Re/p* by Peter Butt.

It might be helpful to start by defining some terms. A spectrum analyzer is an instrument that supplies the user with amplitude versus frequency information about a signal or medium. While there are many ways to obtain this information, the spectrum analyzer provides the information in a continuous and concise manner.

There are essentially two ways to construct a spectrum analyzer — the serial and the parallel method. The most common serial approach is the sweeping filter analyzer. Here a bandpass filter is swept over the spectrum of interest and the amplitude at the output of the filter is plotted against the center frequency of the filter to achieve the familiar XY response plot. This is done using either a CRT display or an XY plotter for hard copy. This method provides very good resolution, high accuracy and a moderately priced instrument. The disadvantage is that it is not *real time*. The spectrum sweep for audio frequencies takes a relatively long time, in the order of seconds, and in many cases this is simply not fast enough. The signal may change much faster than the sweep time and information will be lost. This technique, then, is usually only used in the lab to characterize a non-varying spectrum. There are a number of variations of the serial approach using voltage tunable filters, frequency transformers or heterodyne analysis and various digital techniques including time compression, sampling, digital filtering and fast Fourier transforms.

The second method of spectrum analysis is the parallel filter approach. Here several fixed bandpass filters divide the spectrum into discrete bands. Each filter feeds its own detector and the detector outputs are displayed in a bar graph format

in the popular amplitude vs frequency presentation. This is a real time analyzer as no information is ever lost. The entire spectrum is monitored continuously. The obvious disadvantage of this approach is that resolution is directly proportional to the number of bands or filters used. In practice between 10 and 30 bands are popular with each band having a width of between 1/3 and a full octave. This approach is not particularly complex, but does involve a lot of circuitry in the form of precise filters.



There are variations of the parallel approach as well. Some use a digital technique to achieve the equivalent of up to 500 separate bandpass filters. These instruments are costly, sophisticated and usually out of reach of the average studio.

With the understanding of what a real time analyzer is a look at some of the applications of real time analysis in the studio follows.

### APPLICATIONS:

Applications fall into two categories — production oriented and test and measurement. In the latter category we have the best known professional audio application of a real time



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analyzer; namely, monitor and sound system equalization or voicing, and response evaluation of transducers such as microphones, loud speakers, tape recorders, etc.

In this application a reference signal of known spectral distribution is passed through the medium and the resultant viewed on a real time analyzer. The most popular and convenient reference signal is *pink noise* as the energy distribution in each octave is the same. Thus, the pink noise response, shown on a real time analyzer, is a straight horizontal line. Response deviations contributed by the medium under test will show up as deviations of this straight line.

In monitor system equalization, an equalizer (usually a 1/3 octave filter set) is inserted in the monitor chain. This equalizer is adjusted to obtain the closest response to a straight line possible by using a microphone placed in the listeners' position. *Tuning* of a system in this way is substantially faster than other methods and the chances of error are greatly minimized as the entire spectrum of interest is visible at one time.

This same technique may be used to evaluate and adjust

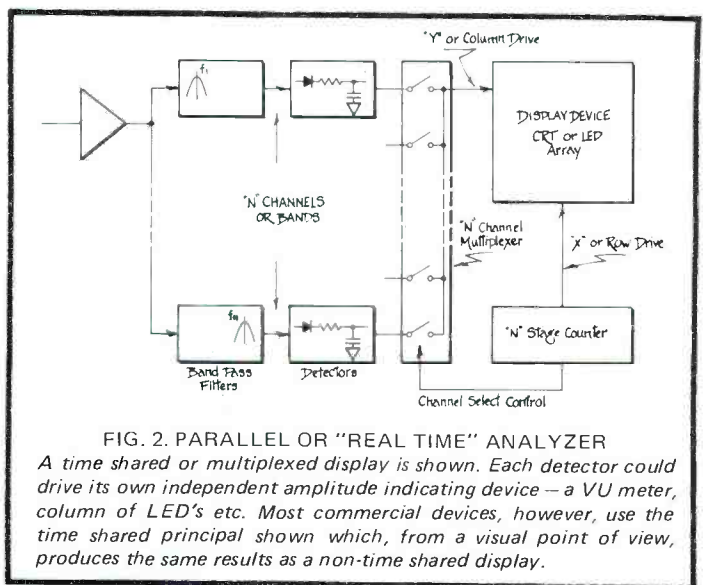


FIG. 2. PARALLEL OR "REAL TIME" ANALYZER  
A time shared or multiplexed display is shown. Each detector could drive its own independent amplitude indicating device — a VU meter, column of LED's etc. Most commercial devices, however, use the time shared principal shown which, from a visual point of view, produces the same results as a non-time shared display.

### What is "Pink Noise"?

Everyone is familiar with a sine wave signal generator as used in testing and other applications. Less familiar is the noise generator. White noise is a signal whose amplitude distribution is constant over a particular spectrum, averaged over a particular time interval. White noise is similar to white light — white light contains all the visible colors; white noise contains all the audible sounds or frequencies. (White noise may, of course, extend beyond the audio spectrum well up into the microwave region.)

In white noise, the amplitude at 1kHz is the same as at 10kHz as indeed it is at all frequencies.

Audio frequency measurements are usually made using a logarithmic frequency scale. We consider the spectrum band from 10kHz to 20kHz as important as the band from 100Hz to 200Hz. There are, of course, more "cycles" from 10kHz to 20kHz, 10,000 as a matter of fact, than from 100Hz to 200Hz where there are only 100. But a change of, say 100Hz or cycles is more noticeable at 100Hz than at 10kHz. It is more convenient to use a log frequency scale or refer to the spectrum in octaves. Starting at 20Hz there are almost exactly 10 octaves to reach 20kHz. 20Hz to 40Hz is the first, 40Hz to 80Hz the second octave and so forth. The tenth is approximately 10kHz to 20kHz. Each higher octave contains progressively more "cycles" as a log scale would dictate.

White noise has equal energy for a given number of cycles. For example, 100Hz to 200Hz has the same amplitude as 10,000Hz to 10,100Hz, a band of 100 cycles. (If white noise is filtered through a 3dB/octave roll off filter, what results is called pink noise.) This

signal has equal energy per octave band. With pink noise the energy in the band 20Hz to 40Hz is the same as that in the band 10kHz to 20kHz.

For this reason pink noise is a more popular reference signal for audio work. Most real time analyzers have a log frequency scale; that is, they divide the spectrum into octaves or fractions of octaves. Pink noise will generate a horizontal line on these analyzers.

### How do we produce calibrated noise?

There are many ways to generate white and pink noise. The most popular method, until recently, was using the characteristic noise of a semiconductor junction — usually a "noisy" diode. The amplified signal is white noise and by passing this signal through a filter pink noise is generated. This signal is called truly random noise.

White noise may also be generated using a digital shift register with feedback. Using a clock frequency several times the high frequency limit of the spectrum generated and an appropriate filter, a signal of excellent spectral purity may be generated. Again the primary output is white noise, a filter will modify it to pink noise.

Digitally generated noise is called pseudo random noise. This is because the signal, although random, has a periodic, repetitive character. The period is long in comparison to the frequencies generated, usually about one second, but is not truly random as is the "noisy" diode. This is an advantage, however, as the signal is predictable. That is, during one period there is a 100% confidence factor that all the frequencies the circuit is capable of generating are, in fact, generated. In truly random noise, at least in theory, one would wait an infinite length of time to have all frequencies generated.

### Averaging Time

This brings up the question of averaging time. To measure the amplitude of a signal we use a detector. The response characteristics of the detector are determined by the time constants used and the circuit chosen. It may be peak responding, average responding or RMS responding. In addition, attack and decay times may be varied to achieve "slow" and "fast" RMS or average detection.

A white or pink noise signal does not contain information at every point of the spectrum at every instant. Rather, each point of the spectrum is generated occasionally, perhaps every few milliseconds, perhaps only every few seconds. It can be seen that an accurate amplitude reading is possible only if the level of the signal at the point in question is averaged over a time long enough to provide a steady reading.

With truly random generators the averaging time must theoretically be infinite for 100% accuracy. In practice an averaging time of a few seconds will give a completely acceptable result. With pseudo random generators, however, we need average only one period for 100% accuracy. Since each period is similar to the previous, the information is no more accurate by averaging over a longer time. Usually the averaging time can be made substantially smaller with pseudo random generators than with truly random generators. Also the "bounce" or fluctuations of a truly random generator are indeed quite random whereas a pseudo random signal produces fluctuations with predictable and continuous bounce. It is usually easier to provide detector time constants to smooth out these fluctuations.

other items of studio equipment. Line up of a tape recorder, checking the performance of a microphone, speaker or console can be simplified and expedited using real time analyzers. The technique is the same — pink noise fed to the device under test and the output fed to the real time analyzer.

With the quantity of equipment in use in today's studio and the number of adjustments to be made on a multitrack tape machine, this method has decided advantages. Fast response and level checks of each track of a tape machine and each channel of a console can be made before every session in a matter of minutes. This goes a long way to increase the confidence level of mixer in his equipment.

#### PRODUCTION APPLICATIONS:

The production applications of real time analysis are less well known. Contemporary recording techniques, as we all know, permit a high degree of flexibility and variation in signal modification. Modern recording consoles and outboard equipment such as equalizers, compressors, limiters and other devices permit the spectral shape of a signal to be grossly modified: 10dB variations are common and extreme 50dB variations are possible. The net result is that the spectral energy distribution of the resulting program is perhaps artistically pleasing, but quite "unnatural."

The natural spectral distribution of sound, from voices, musical instruments or simply noise, usually shows a dominant mid range, and less high and low frequency energy. Many technical parameters have been chosen based on the assumption of *natural* spectral distribution. Magnetic and disc recording and FM broadcast use reciprocal encode and decode response to extend the dynamic range of these media. If an unnatural distribution is passed through these media various

forms of distortion can result. This is shown as high frequency distortion evident in some tape, cassette and disc recordings, the high frequency breakup in some FM broadcasts and the tracking problems in some discs.

Often the solution to a problem is simplified if precise objective details are known. This is true in this case as well. Knowing the limitations of the medium and the spectral distribution of a signal, subtle adjustments can be made. This is where a real time analyzer is more than handy.

Using a real time analyzer during the production stage creates a new awareness of spectral energy distribution. By comparison, the familiar VU and PPM meters traditionally used are shown to be quite deficient. An analyzer, reading the mono sum of a mix while its happening, produces a "sixth sense" complementing the subjective nature of the mixers ears. It soon becomes apparent why certain mixes sound top or bottom heavy, why some sounds are louder than others even though they have the same VU reading.

As the mixer or producer becomes more aware of spectral energy distribution he will, no doubt, tend to mix in such a way that disc cutting and tape duplication are less of a problem. Most mixers at some point in their careers have had what they thought was a fantastic mix only to find that they sound somewhat less than terrific on the disc. They blame the mastering house when the problem is really one of "unnatural" spectral distribution trying to fit the electro-mechanical constraints of the disc cutting process.

A real time analyzer takes much of the "subjectivity" out of listening. No one is saying, "listen by looking at an analyzer," but it must be acknowledged that the ear is a very subjective device. The listening process is, of course, further modified by variances in monitor systems, environments,

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temperature, air pressure, listener fatigue and other parameters. The analyzer, on the other hand, is a strictly objective device. It doesn't relate to artistic input that the ear perceives, but it does help clear up confusion when something *sounds* incorrect.

A spectrum analyzer also has a considerable value in the actual recording session. A lot of recording process involves trying to find the right character or "feel" of a sound. The recording engineer or producer is looking for a particular guitar sound, drum sound or string sound. He usually achieves what he wants by spectral modification — using a program equalizer, trying a different microphone or different microphone positions, or some of assorted types of compression. Having a calibrated display of the spectral distribution is invaluable in understanding the content of the sound.

Often you know what you're looking for. You have heard the wanted sound on a disc or you've been given a tape to duplicate. Playing this material through an analyzer will undoubtedly show the desired distribution. Playing your raw sound will show the differences. Then with equalization and other techniques the spectrum can be shaped to approach the sound of the original material.

The analyzer also shows a graphic picture of what happens during these changes. For example, you move a microphone and see a 4dB reduction at 4kHz, or boost a mid range equalizer and see the 8kHz harmonic of a sound increase 6dB.

Then too, if you work in several studios and find a different perspective in each because of different monitor situations an analyzer can be equally helpful. The analyzer at the console output tells you what you're putting on the tape — the monitor system and your ears give their interpretation of what you're recording.

Applications of spectrum analysis are numerous. Only a few have been covered here. More will become obvious as an analyzer gets some use. What follows is a look at some of the products available.

#### PRODUCTS AVAILABLE:

There are several real time audio frequency analyzers on the market. The following does not pretend to be a definitive round up, but will serve to illustrate some of the typical models available.

General Radio, Bruel & Kjaer, Nicolet Scientific Corporation, EMR Schlumberger and Honeywell manufacture a number of low frequency real time analyzers. While these are truly excellent instruments with high accuracy, their sophistication and price usually puts them out of reach of the average professional audio user. Most of these devices are priced from \$5,000 to \$20,000, and beyond.

There are, however, a number of lower priced units designed particularly for professional audio applications.

Before we discuss these products it would be helpful to clarify one particular specification.

All analyzers use a detector on the output of each band pass filter to obtain the amplitude value of the signal in that band. The response characteristics of this detector may take several forms. Popular characteristics are Average, RMS and Peak. Each of these may be defined by a mathematical formula and approximated with an analog circuit. RMS, or as it is often called, TRUE RMS is the most difficult to achieve. The sophisticated lab analyzers usually employ accurate and expensive RMS to DC converters. Most of the lower priced devices use an average responding characteristic but calibrate the scale as if it were true RMS. Thus, although they specify

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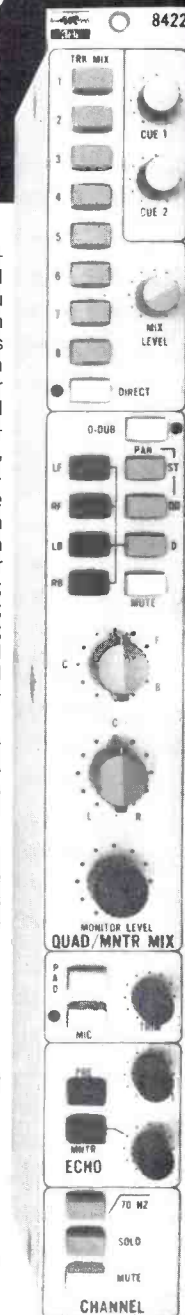
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- MODEL C8422** Control Room Monitor Module
- MODEL S8422** Studio Monitor Module
- MODEL T8422** Communications and Cue Module
- MODEL MB8422** Input Module Mother Board
- MODEL 3000** Variable Parameter Equalizer
- MODEL 3100** Graphic/Shelf Equalizer
- MODEL CL-20** Compressor-Limiter



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As the detector is on the output of a narrow band filter, the possible waveshapes it may see are very close to a sinewave. This greatly reduces the error between Average and True RMS and, for the applications in which they are used, this small error may be disregarded.

There is also some variance in the response time of an Average detector. IEC specifies the characteristics for SLOW RMS and FAST RMS. Some products use this spec. Others tailor the time response to best suit what the analyzer is looking at: very slow for pink noise and medium to fast for music. There is no ideal time for both applications.

Finally there are peak responding detectors. These, as their name implies, measure the peak value of the AC signal. They usually have a super fast attack, reaching their correct value within a few cycles or microseconds, and a slow decay falling to zero in a few seconds. They cannot be used for pink noise but give very useful information about program signals.

Now let's look at some of the products.

### ALTEC MODEL 8050A 1/3 OCTAVE REAL TIME SPECTRUM ANALYZER

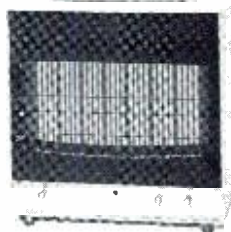


This device is actually manufactured by Hewlett Packard for Altec, and is a variation of earlier (and now discontinued) 'loudness analyzers' produced by HP. It uses a CRT display and provides 27 contiguous 1/3 octave bands. It was specifically designed to

be used with Altec's monitor system equalization technique. It has two switchable detector response characteristics — slow and fast RMS.

Although specifically designed for monitor system equalization set up, it is used by a number of studios to “look” at program material. It provides a 20dB display range and may be operated with either mike or line level input signals.

### AUDIO DESIGNS AND MANUFACTURING MODEL 660 AUDIO SPECTRUM ANALYZER



This device, a variation on the firm's VU-SCAN multi-channel level display, provides 28 contiguous 1/3-octave bands. The display is a large screen CRT, actually a television monitor. Detection is switchable to peak or RMS and an additional feature allows holding

the highest levels in the peak mode. Display range is about 28dB and, like a VU meter is linear although calibrated in dB. Input sensitivity is adjustable over a wide range from microphone to line level using a switchable 40dB pad and a 40dB gain adjustment. The device may also share the same display as the company's VU-SCAN product. It is primarily intended for console mounted applications and spectrum analysis of program signals although it may also be used with a pink noise generator for acoustic analysis.

### WHITE INSTRUMENTS MODEL 140 REAL TIME SPECTRUM ANALYZER

This instrument is quite similar in application to the Altec unit. However, in place of a CRT display it uses an 11 x 28





array of light emitting diodes. Like the Altec, it provides 27 bands of information. Additionally, a wide band channel indicates overall level. It provides a switchable 10 or 20dB display range and has a microphone level input.

The unit also provides an internal pseudo random pink noise generator. The detectors have a slow response characteristic to provide the smoothest amplitude indication with the noise signal. Like the Altec, it's primary application is monitor system calibration.

**COMMUNICATIONS COMPANY MODEL ARA-412  
REAL TIME ANALYZER**



This unit is very similar to the Altec device, as well, but excludes the CRT display. It is designed to operate with a user supplied DC oscilloscope. Again it provides 27 contiguous 1/3 octave bands.

This instrument provides both a line level input and microphone level input and provides vertical and horizontal drives to an external DC oscilloscope. The unit displays a range of 27dB with a log or dB amplitude scale.

**AMBER MODEL 4550 AUDIO SPECTRUM DISPLAY**



This device is quite different from the four just described. Its primary application is analysis of program material. It uses a 10 x 10 LED-array and provides 10 contiguous full octave bands. Display range is switchable to 10 or 20dB and it accepts line level

inputs. Four inputs may be selected in any combination.

The detector response characteristics of this device are peak responding. This was chosen to suit its intended application: "looking" at music for possible spectral imbalance. In this respect the detectors capture minute peaks which would be missed by slow average RMS detectors. (As an option the 4550 may be ordered with RMS detectors or field modified for this feature. If the device is to be used with pink noise signals this version must be used.)

An additional unique feature of the Amber is the two digital memories. They are independent and may be used to sample or accumulate peaks during a program. It is possible to view the display in real time while one of the memories accumulates peaks. Switching the display to the memory at the conclusion of the program will show the highest peaks attained during the program.

Spectrum analysis is a whole new information generating technique. No one presumes its use will solve all problems, but it can provide an amazing insight into what causes some of today's recording problems. Every mixer, recording engineer, mastering engineer and even musician should try at least once to hang a spectrum analyzer across the console output during his session and see what he has been listening to for so many years. It's quite enlightening.

# 4 MIXING CONSOLES

For the Price of 1



- A RECORDING CONSOLE
- A SOUND CONSOLE FOR THE ROAD
- A MIXDOWN CONSOLE
- A SOUND CONSOLE FOR THE CLUB

The QM-8A is the first fully professional, value-engineered mixer designed for demanding music people. This second generation system is the product of over four years of field experience and evaluation. Its electronic and mechanical components are chosen to obtain uncompromising performance with maximum dollar value. Whether you're interested in laying down clean tracks in your next session, or in feeding pure, undistorted audio to any size sound reinforcement system, the QM-8A has a lot to offer. Look at the features, the specifications and the price...we think you'll agree.

**STANDARD FEATURES INCLUDE:**

- 8 Balanced, low-Z mike inputs
- 8 Unbalanced, high-Z line inputs
- 4 Monitor outputs
- 4 Mixing buss outputs
- Expander input jack
- Complete 8x4 monitor system
- Complete talkback system
- Headphone cue system

The QM-8A is made to bring out the artist in every technician, as well as the technical excellence every artist deserves. High in reliability, versatile in function, this console is one of a kind...four times the system you'll find anywhere.

*For full technical specifications and the name of your nearest dealer, write or phone (213) 841-0970.*



AUDIO LABS, INC.

Quantum Audio Labs 1905 Riverside Dr. Glendale, Ca. 91201

*Quantum Audio Labs is an independent manufacturer and is not affiliated with any retail stores, although companies bearing a similar name may appear on Q.A.L.'s authorized dealer list.*

Circle No. 134

DISCOTHEQUE SOUND SYSTEMS

– Signal to noise ratio: At typical disco SPL's, noise can get quite annoying. A minimum of 60dB in the phono preamps and 80 or so in the mixer proper should be acceptable.

– Equalization: Input EQ need not be sophisticated. A graphic equalizer on each output channel is highly recommended, though.

Turntables

Broadcast units are recommended here, as most consumer units aren't built to take back-cueing and other forms of punishment. Acoustic isolation of mountings is important, since feedback can be a problem if volume is high. 4 or 5 gram tracking forces are typical, so the cartridge used must be able to withstand them.

Rumble Filter – (Note: Important!)

Since the program source in discos is by definition records, it is *absolutely essential* that the system include a rumble filter. Turntable rumble, acoustic feed-

back, and (most commonly) warped records all give rise to subsonic noise that can pass unattenuated through modern direct coupled equipment, with potentially damaging effect on the low frequency speakers. This noise may modulate the desired program, or may give no warning at all until the woofers bottom. A filter that cuts off sharply at 25-30Hz, with at least a 12dB/octave slope, is mandatory when records are being played loud.

PROGRAMMING AND PRODUCTION TIPS

None of the record company employees with whom we talked were aware of any special production techniques used with material aimed specifically at the disco market (except for the process of splicing in duplicated passages to extend the length of a selection). This is unfortunate, since conventionally produced records can often benefit greatly from re-equalization on playback (via the recommended graphic equalizer). Some tricks that have proven successful. (pro-

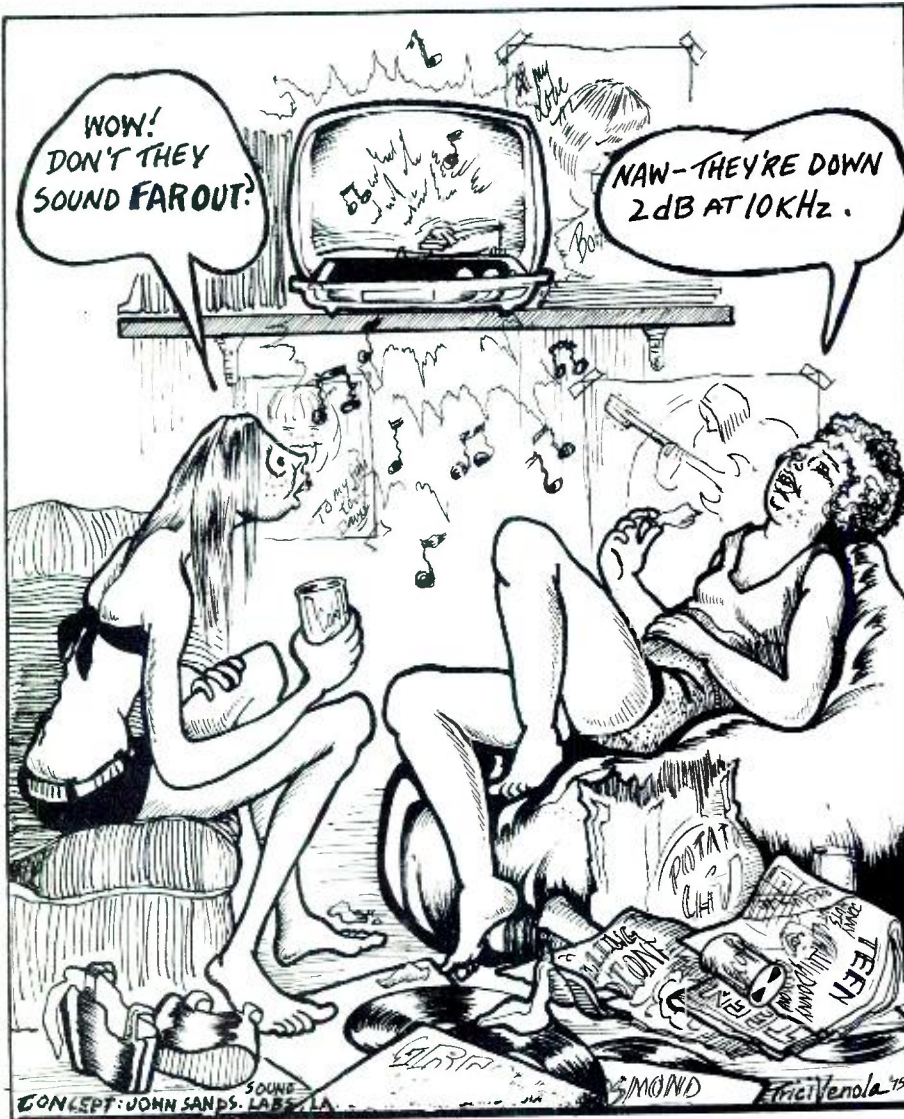
ducers take note!)

– Boosting the deep bass. Virtually every step in the record-making process entails some loss of low frequencies. This is compounded by losses in the playback equipment. Boosting the bottom registers helps compensate for this lost bass, and greatly enhances the sensory impact of dance music (as long as powerful bass speakers and amps are available). As much as 10dB of boost at 30Hz and 3-6dB at 60Hz may be useful (*but make sure you have a good rumble filter!*)

– Cutting mid-bass. This helps cancel room and speaker resonances in the 80-200Hz range, and can improve naturalness and definition. Note: Cerwin-Vega will shortly introduce an economical stereo equalizer featuring *half*-octave, ISO-centered bands between 22 and 125Hz. This will give precise control over narrow-band bass aberrations without needlessly complicating the picture at mid and high frequencies.

– Boosting extreme highs. Highs are heavily absorbed by clothing, bodies, etc. Boosting at 15kHz by a few dB can restore "sparkle" and liveness to the sound. Avoid extreme boost that may damage tweeters.

– Cutting midrange. Most pop music is mixed for maximum apparent volume and "up front" vocals (both of which involve boosted midrange). Neither may be desirable in a disco situation; in fact, at the high sound levels involved, the effect is likely to be harsh and strident. Since the threshold of pain is lowest in the 1-3kHz range, cutting these frequencies by a few dB will allow higher overall volume without causing discomfort.



BOOK REVIEW

HANDBOOK OF MULTICHANNEL RECORDING

Author: F. Alton Everest  
(Tab Book's No. 781)

This is a book that covers it all – most of the things one has to know to make the highest-quality professional audio tape recordings. Here are, at first-hand, the money- and time-saving tricks a master recording engineer acquires in a lifetime, plus how to employ the modern techniques involved in dubbing, special effects, mixing, reverb, echo, and synthesis – for both stereo and quad!

In three extremely comprehensive Chapters the author covers every facet of studio design, including suggestions on how to pick the site for a studio, the pros and cons of leasing vs buying, and the basic requirements with respect to acoustics. The author tells how to evaluate existing facilities acoustically, and takes the reader through a broad spectrum of actual in-use studios of varying complexity.

The final Chapter alone might have



been enough justification for the entire book — it's a comprehensive treatment of the budget sound-recording operation, and it tells how to get high-budget sound from the least possible equipment at the lowest possible dollar cost.

**CONTENTS: THE RISE OF MULTITRACK RECORDING:** Separation Recording — **MANAGEMENT FOR TRACK SEPARATION:** Achieving Separation; Separation By Distance; Microphone Directivity; Baffles; Separation and Studio Acoustics; Electronics Separation; Contact Pickups For Separation — **THE AUDIO MIXING CONSOLE:** The Function of a Console; Spectra-Sonics Model 1024-24 Console; Audio Designs NRC Series Console; Neve Console — **ANCILLARY EQUIPMENT:** Reverberation Devices; Noise Reduction Systems; Compressors and Limiters; Expansion and Gating; Program Level Indicators; Foldback — **MULTITRACK RECORDERS:** Signal-to-Noise Ratio; Crosstalk; Capstan Drive; Fixed and Variable; Control Logic; Sync Overdub; Representative Multitrack Recorders — **MONITORING FACILITIES:** Monitoring Room Acoustics; The Home Environment; Early Sound and Overhead Reflectors; Monitoring Loudspeakers and Amplifiers; Equalization of Monitoring Room; Headphone Monitoring — **SPECIAL EFFECTS:** Reverberation; Phasing; Music Synthesizers; Other Special Effects — **STEREOPHONIC AND QUADRAPHONIC RECORDINGS:** Stereophonic Recording; Quadrasonic Recording; Monaural/Stereo; Quadrasonic Mixing; Experimental 4-Channel Drama; Mixdown — **MULTITRACK IN ACTION:** Microphone Placement; Channel Assignment; Cue Mixes; Mixdown; Recording Outside the Studio — **LOCATING AND LAYING OUT THE STUDIO:** Location; Build, Buy, or Lease?; Taxes and Zoning; Technical Services; Acoustic Factors; Other Considerations; Some Real-Life Studios — **MULTITRACK STUDIO ACOUSTICS:** Eye vs the Ear; Excursions; Acoustical Principles; Composite — **CONSTRUCTING THE STUDIO COMPLEX:** Criteria; Barrier Requirements; The Floating Principal; Acoustic Doors; Sound Lock; Sealing Acoustic Doors; Observation Windows; Air-Conditioning Noise; Noise From Ground Vibrations; Noise From Lamps; Conduits; Supervision — **THE BUDGET MULTITRACK OPERATION:** Sound On Sound; Sound With Sound; The Professional Approach; The Budget Multichannel Console; Budget Multitrack Recorders; Noise Reduction for Budget Operations; Premixing — **GLOSSARY — INDEX.**

322 pages and 201 illustrations.

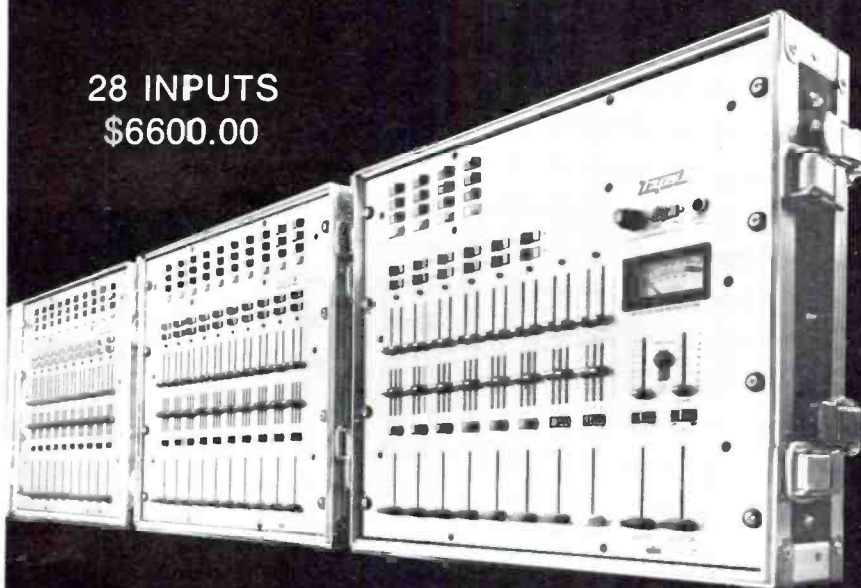
\$10.95 Hard Bound, \$7.95 Paperback.

**HANDBOOK OF MULTITRACK RECORDING** is available from R-e/p Books. Send check or money order. \$10.95 hard-bound, \$7.95 paperback to R-e/p Books, Box 2449, Hollywood, CA 90028

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THE FIRST TRULY EXPANDABLE/CONTRACTABLE  
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28 INPUTS  
\$6600.00



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Each input contains the following: mix level control, solo switch, 5-band graphic equalizer, monitor and echo send, LED peak indicator, mic pads and group assign switches. Output control module features include: subgroup level controls, with solo switch and equalizers; house, echo receive, and monitor level controls. Additional features on the output module are: VU meter and peak indicator switchable to any input or output through the solo system, headphone jack, headphone level control, and preview selector switch for listening pre or post fader; announce level controls for monitor and house, two auxiliary receive controls for line inputs. Back panel features: XLR-type connectors for balanced inputs and outputs, on/off switch for built-in phantom power supply for condenser microphones, optional multi-pin connector for snake to replace mic and line inputs, external equipment jacks: echo send and receive jack, subgroup outputs, and subgroup defeat switch that inactivates the subgroup system for mono operation. Write or circle number for literature and specifications.

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**AUDIO SYSTEMS DIVISION**  
5559 CAHUENGA BLVD.  
NO. HOLLYWOOD, CA 91601

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Now if you're rich and famous (or just rich) you probably don't need us. But if you have more talent than money, check out the TEAC/Tascam Series 70. You can find your nearest Tascam Series dealer by calling (800) 447-4700. In Illinois, call (800) 322-4400. We'll pay for the call.

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When you've got more talent than money.

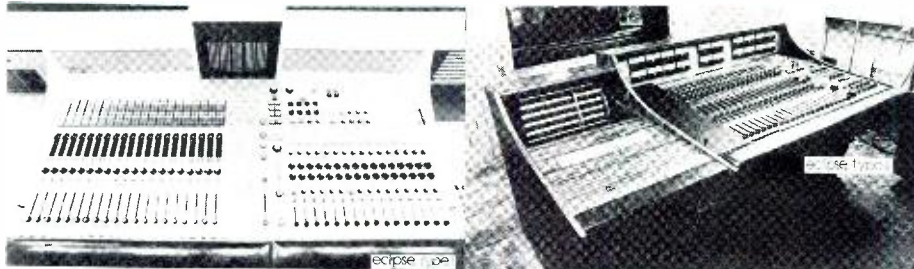
TEAC CORPORATION OF AMERICA 7733 Telegraph Road, Montebello, Calif. 90640 ©TEAC 75

\*Prices do not include consoles. Actual retail prices will be determined by authorized dealers.





# New Products



## SPHERE ECLIPSE CONSOLE MODELS TYPE I & TYPE II

The new line of consoles are provided with inputs from 16 to 48 and 16/24 or 32 outputs. Standard features include 4 echo and 2 cue channels, simultaneous Quad-Stereo and Mono mixdown, random access group submasters, graphic equalization on all inputs, 2 preset mute buses, solo with echo and panning, patching, producer desk, etc.

The console utilizes the latest discrete

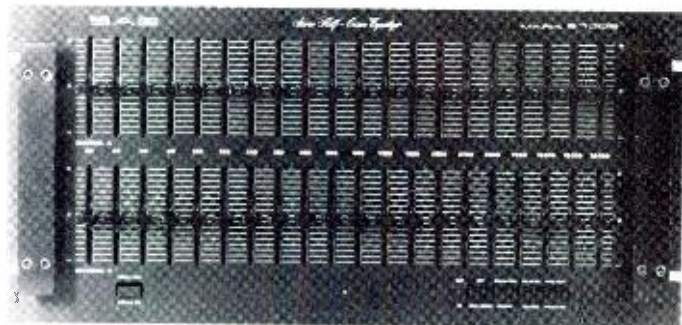
operational circuits to achieve extremely good performance specs and reliability.

Mixlog is an option that accurately logs positions of faders, echo sends and pan pots for future reference on a mix.

**SPHERE ELECTRONICS, 20201 A PRAIRIE AVE., CHATSWORTH, CA 91311, (213) 349-4747.**

**SPHERE AUDIO SALES, 478 DEVENS DRIVE, BRENTWOOD, TN 37027 (615) 794-0155.**

Circle No. 137



## SAE DEBUTS MODEL 2700B HALF OCTAVE EQUALIZER

The SAE (Scientific Audio Electronics, Inc.) Model 2700B offers the user precise, and it is said, heretofore unprecedented program control over 20 different frequency bands.

In addition to the half-octave frequency control the unit contains a pink noise generator with harmonic and intermodulation distortion of less than 0.02%. The pink noise generator provides an energy constant, wide band of noise for reference use in determining proper channel balance, room response and speaker phasing.

Professional slide controls give the user up to  $\pm 16$ dB range at any or all 20 frequency bands. This equalization capability allows the user to overcome common room resonances, and to compensate for other listening environment, acoustic and speaker deficiencies. Another use of the equalizer is in producing pre-equalized tapes.

Circuitry in the 2700B utilizes toroid inductors in combination with low loss capacitors and low noise professional slide potentiometers for extremely low noise (greater than 90dB) and accurate equalization curves. The toroid LCR circuit provides low distortion, phase shift, and noise.

Input and output amplifiers are full complementary in the output stage allowing for full voltage swing into low  $z$  loads, and there is no slew limiting, even at high output levels. The result is a stable, low distortion drive circuit with 11 volts RMS into 600 ohms or +23dBm.

The unit offers individual IC control for the positive and negative power supplies. This provides power stability to the drive circuits and lower noise. The 2700B comes with a 5-year free service contract on parts and labor, and is offered in a 19 inch rack mounted version with rack handles and 600 Ohm output.

Price: \$600.

**SAE, 701 MACY ST., LOS ANGELES, CA 90012.**

Circle No. 138

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**6912 melrose avenue**

**hollywood, california 90038**

Circle No. 139



**OAE MODEL 400-RSM SEARCH & CUE COMPUTER**

Pictured is the new Search & Cue Computer from OAE. This unit will automatically return the tape to any one of 16 locations stored in the computer's memory.

Using an exclusive all digital technique, the computer continually calculates the optimum tape velocity and prevents the recorder from overshooting its destination. All input data is obtained from a single optical pick-up mounted under the tape deck. All output signals are fed to the tape transport "remote" input socket.

The unit is easy to install and compatible with almost any tape recorder. Applications include multitrack overdubbing and mixdowns, live recording, duplicating, on-the-air radio programming, etc.

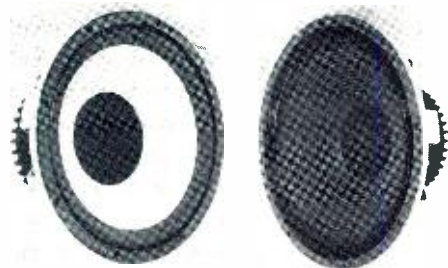
Price: \$1495.

**OLIVER AUDIO ENGINEERING, 1143 NORTH POINSETTIA DRIVE, LOS ANGELES, CA 90046 (213) 874-6463.**

Circle No. 140

**CETEC 2831 AND 5831 12" AND 15" WOOFERS**

The Models 2831 and 5831 incorpor-



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**STL** test tapes are rated tops for accurate Azimuth Reference . . . the most accurate and dependable tapes you can buy.

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## **TABER** Manufacturing & Engineering Company

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Minneapolis distributor: Sound 80, Inc.

Circle No. 141

ate the time-tested features of other Gauss loudspeakers such as dual spider system, rigid 8-spoke frame and 18-1/2 pound magnet assembly using Alnico V as the magnet material. Specifications for Model 2831 include rated power capacity of 150 watts (continuous sine wave power), 8 ohms nominal impedance, 43dB sensitivity and free air resonance of 19Hz. The Model 5831 has rated power capacity of 200 watts RMS, 8 ohms nominal impedance, 49dB sensitivity and free air resonance of 32Hz.

**CETEC AUDIO, 13035 SATICOY ST., NO. HOLLYWOOD, CA 91605. TELEPHONE (213) 875-1900.**

Circle No. 142

**QUANTUM AUDIO QM-8A CONSOLE**

According to the company the QM-8A incorporates every audio mixing control needed for recording masters or demos, and for sound reinforcement on the road or in the club. A fully professional, value-engineered mixer, the QM-8A is designed for demanding music people.

The console has 8 input channels, continuously variable equalization at four frequencies, panning between pairs of output channels, two echo sends and a separate headphone/cue mix buss.



In addition to all the normal monitoring functions, the QM-8A monitor will switch to direct line inputs for separate mix down without disturbing the front panel program or controls. A talkback mike and control is included in the monitor section.

Only quality conductive plastic faders, true VU meters and ultra-low noise circuitry is used in this product.

**QUANTUM AUDIO LABS, INC., 1905 RIVERSIDE DRIVE, GLENDALE, CA 91201. TEL: (213) 841-0970.**

Circle No. 143

**NEW STEVENSON ELECTRONIC CROSSOVER FEATURES CONTINUOUSLY TUNEABLE OUTPUTS IN-PHASE AT ALL FREQUENCIES**

The Stevenson Model X0312, a new electronic crossover that keeps all outputs in phase at all frequencies and provides continuously tuneable crossover frequencies from about 100 to 1000Hz and 1000 to 14,000Hz, has been announced.

The X0312 is said to have distortion of less than 0.1% and a signal-to-noise ratio better than 80dB. High- and low-pass filters in each crossover are permanently crossed at 3dB down. The state-



We put some of our best heads together and came up with a mike that will satisfy almost everybody. The multi-module AKG electret condenser system.

It's an AKG condenser microphone. It's an electret. It can be phantom powered also. (Your choice.)

A twist of the wrist changes modules from a cardioid to a cardioid/integral windscreen to an omni-directional to a levelier.

To make sure the system performs at top specifications we make it with FET pre-amplifiers and gold-vapored Teflon™ diaphragms in the modules. Humidity can't hurt it. (Temperature/Humidity range from -5° F/99% to +125° F/95%.) And aging won't cause deterioration either.

It's a professional system in every way. Sensitivity variance between modules is remarkably low.

College stations and studios on a tight budget find the AKG compact electret system an easy step-up to AKG quality without straining the budget. All four modules are interchangeable on the power supply/handle. That saves equipment purchases.

The AKG electret system components are all available separately or in several economical combinations. They're perfect for young recording outfits that need growing room without obsoleting anything.

See your professional equipment dealer. Or write to us. Good things happen when you put our heads together.

**AKG MICROPHONES • HEADPHONES**

distributed by:  
PHILIPS AUDIO VIDEO SYSTEMS CORP.  
AUDIO DIVISION  
91 McKee Drive, Mahwah, New Jersey 07430  
A North American Philips Company



## Four heads are better than one.

Introducing the AKG multi-module miracle mike.

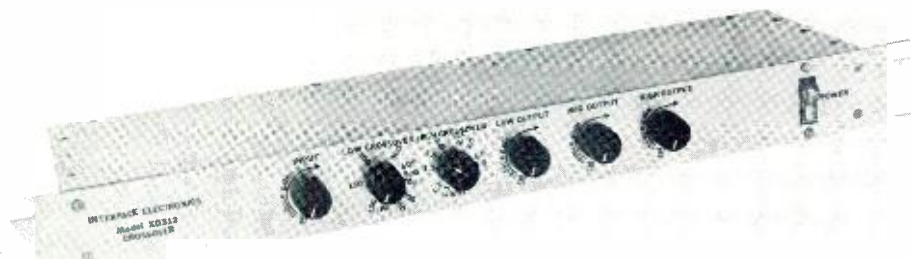


TM—E. I. du Pont de Nemours & Co.

Circle No. 144

[www.americanradiohistory.com](http://www.americanradiohistory.com)

R-e/p 59



variable filter provides a 12dB per octave Butterworth response. The sum signal is flat  $\pm 1$ dB from 20 to 20,000Hz.

The X0312 has balanced 600-ohm transformer outputs that are individually adjustable to a maximum of 8 volts. Voltage gain is adjustable to a maximum of 2. **INTERFACE ELECTRONICS, INC., 3810 WESTHEIMER, HOUSTON, TX 77027.**

Circle No. 145

### PEAVEY 1200 STEREO MIXER

The new 1200 Stereo Mixer features 12 channels with LINE or MIKE input capabilities on each channel, and a combination input attenuator/select switch for input assignment and padding of either input. Each channel features 600 ohm transformer balanced, low impedance mike inputs and 50K ohm unbalanced inputs.



Other features include: High and low equalization on each channel; stereo pan on each channel; three send controls on each channel with pre and post capabilities; output slide attenuators on each channel; master control area with left and right main slide attenuators with low, middle, and high equalization and monitor slide attenuator; effects master, return, and pan controls; 600 ohm transformer balanced outputs on left and right main and monitor; lighted VU meter on left and right mains, externally adjustable.

Suggested retail price: \$949.50. **PEAVEY ELECTRONICS CORP., P.O. BOX 2898, MERIDIAN, MISSISSIPPI 39301. TEL: (601) 483-5365.**

Circle No. 147

### FREQUALIZER FROM TENNESSEE MUSICAL INSTRUMENTATION

The FREQUALIZER is a professional tuneable equalizer developed primarily for

use in conjunction with musical instruments for concert or studio performance. It is designed around and built from the highest quality components. Its extremely low noise and low distortion make it ideal for even the most critical studio applications. The unit features a tuneable Low Cut Filter at 12dB per octave with a range of 30Hz to 5000Hz. The tuneable High Cut Filter has a range of 4500Hz to 18,000Hz. There is also a completely variable Lo EQ section from 30Hz to 500Hz with up to 30dB of Boost or Cut available. The Hi EQ section is variable from 4500Hz to 15,000Hz with 30dB of Boost available.

Two inputs with separate gain controls are provided, the second input having an EQ/flat switch which bypasses the Freqqualizer in the flat position. A low level output signal is provided at the To Amp jack for input to conventional musical instrument amplifiers, and line level at the Phones jack is provided for headphones or line inputs on studio consoles, power amps, home Hi Fi's, etc.

Control knobs are color coded so that each control group may be quickly identified. The Freqqualizer is packaged in an all-metal rugged cabinet with a painted and epoxy silk-screened front panel. All connections are made through standard 1/4" phone jacks. XLR connectors and balanced inputs/outputs are available upon request. Standard 19" rack mounting is also available at no additional charge.

The Freqqualizer will accept any levels between -30 and +20dBm for 0dBm output level. Overall gain through the unit is a maximum of 30dB. Dimensions are 5 1/4" high x 17" wide x 8 1/4" deep. The radical amount of EQ available from the Freqqualizer makes it ideal for not only highly selective equalization but also multitudes of special effects.

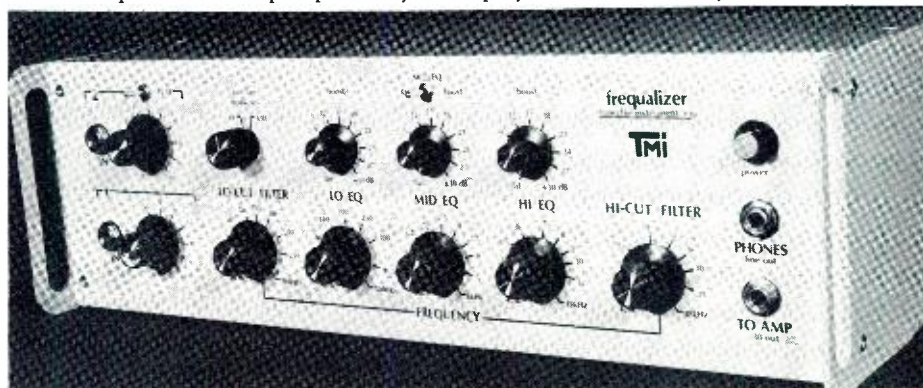
Price: \$485.00

**TENNESSEE MUSICAL INSTRUMENTATION, 2101 JUNE DRIVE, NASHVILLE, TN 37214. (615) 383-1440.**

Circle No. 148

### FOUR VOICE POLYPHONIC SYNTHESIZER

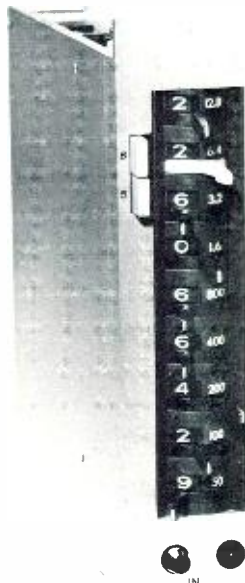
The first commercially available synthesizer on which four notes can be played simultaneously is available from



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### THE GRAPHIC EQUALIZER



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THE CONSOLE COMPANY

Circle No. 146



each module a completely self-contained operating channel. The modules simply plug-in via an 18 PIN PC connector provided with each module.

Known as Models STM-22 Stereo Mike Input Module and STL-22 Stereo Line Input Module, the new units feature extremely low noise, distortion and crosstalk, with excellent frequency response which meets or exceeds NAB proof of performance specifications. Both models utilize the MAP 1731A Audio Operational Amplifier as the active element, providing exceptional stability and reliability of performance.

A unique feature of these modules is independent input to output selection which allows left and right inputs to be separately routed to left, right or both bus assign switches. Signal can then be assigned to either of two output buses. This feature allows the user instant selection of Stereo, Monaural or Combined operation, individually selected at each module.

Other features include: independent left and right mike trim controls, a separate channel on/off switch with provisions for mating logic and on air light control, combined left and right cue feed through detented cue switch at bottom of fader travel and transformer coupled inputs for both mike and line level sources.

Each module measures only 12¼"L x 1½"W x 6"D for compact console con-

struction, with all controls within easy reach of the operator. A 16 input console may be as small as 24" wide.

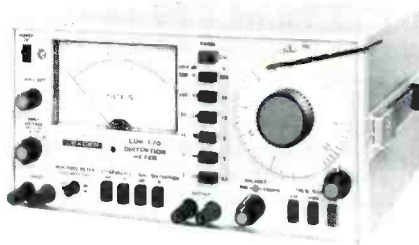
Prices are: Model STM-22, \$336.00, Model STL-22, \$316.00. Shipment is F.O.B. Bohemiz, N.Y. Delivery is 60 days ARO.

**MODULAR AUDIO PRODUCTS, 1385 LAKELAND AVENUE, BOHEMIA, N.Y. 11716. TEL: (516) 567-9620.**

Circle No. 154

**LDM-170 AUDIO DISTORTION METER**

The LDM-170, an audio circuit distortion meter which also measures signal-to-noise ratio and signal levels in all audio frequency circuits, is being made available by Leader Instruments Corp.



The new product offers a balancing circuit to suppress the fundamental frequency in the 20Hz-20kHz range while distortion products are fed to a stable, high gain amplifier for meter readout. Distortion may be measured as low as

0.1% while signal-to-noise ratio can be determined from 70dB. Signal levels may be read from 100uV to 300V. The amplifier is effective to 200kHz and measurements are possible up to and including the 10th harmonic of 20kHz.

The LDM-170 also features a high pass filter with a cutoff at 500Hz; plus 6dB octave attenuation. It also features output terminals for scope connection to observe waveforms or for use as a pre-amplifier in low level circuitry.

The LDM-170 retails for \$549.95 and measures 6½"H x 12½"W x 12"D and weighs 13 lbs. It operates on 115/230V, 50/60Hz power supply.

**LEADER INSTRUMENTS CORP., 151 DUPONT ST., PLAINVIEW, NY 11803, (516) 822-9300.**

Circle No. 156

**SOUNDCRAFTSMEN PROFESSIONAL TWIN-GRAPHIC EQUALIZER TG2209-600.**

A new Studio Quality Unit with two completely independent ten-octave equalizers has been announced by SOUNDCRAFTSMEN for professional use in mix-down rooms, Tape-to-Disc transfer, Radio & T.V. production, P.A. Feedback Suppression, Environmental Equalization, and Sound Reinforcement.

Front panel pushbuttons provide selection of either an equalized or unequalized output, low and/or high shelving, and

<b>MANUFACTURER</b> "MCA" 4007 N.E. 8TH AVENUE FT. LAUDERDALE, FLA. (33308) PHONE: (305) 566-2853	(61554)	<b>DEALER</b> MILAM AUDIO 1504 N. EIGHTH PEKIN, ILLINOIS PHONE: (309) 346-3161
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Circle No. 155

R-e/p 65



zero-gain lites on or off. Separate terminations are provided for input and output of Section A and Section B.

The new TG2209-600 utilizes four Light-Emitting-Diodes to provide a visual front panel display for balancing input to output signal ratios. Other features include two completely separate ten-octave equalization panels, with plus or minus 12dB boost and cut provided individually for each octave. Separate equalized signal zero-gain controls are used for each channel, enabling exact balancing of input to output with a plus 6dB and minus 12dB range. For precise balancing, Light-Emitting-Diodes are used in conjunction with the zero gain level controls so that visual as well as audible balancing can be accomplished quickly and easily.

The new unit features balanced 600

ohm op-amp input as well as output.

\$550.00.

**SOUNDCRAFTSMEN, 1721 NEWPORT CIRCLE, SANTA ANA, CA 92705 (714) 556-6191.**

Circle No. 157

### DUNLAP CLARKE ANNOUNCES DREADNAUGHT 1000 AMPLIFIER

A new professional stereo power amplifier which delivers 500 continuous watts per channel with both channels driven from 20 to 20,000Hz into 4 ohms at less than 0.25% distortion is available from Dunlap Clarke Electronics, two-year-old Boston area manufacturer of audio esoterica.

Dubbed the Dreadnaught 1000, this amplifier was developed specifically to drive studio monitor systems, parallel

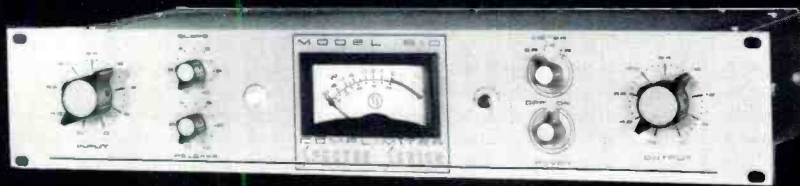
arrays, sound reinforcement and paging systems, and other so called "problem loads" which present difficulties to many super amps with 8 ohm nominal impedance ratings. The Dreadnaught 1000 has a very "stiff" power supply which allows the amplifier to deliver increasing amounts of power to loads all the way down to 2 ohms, with protection circuitry becoming sensitive only at well below 2 ohms.

Since no limiting of any kind is used, the Dreadnaught will deliver over 800 watts per channel continuously into 2 ohms before protective shutdown occurs. The 42-pound transformer and associated supply will deliver over 1,800 watts continuously without overheating and considerably more than that for short periods. Conservative thermal design permits operation without forced cooling, although a pair of two-speed fans are provided as a standard feature for commercial or industrial use or if the user places the unit in close quarters.

The Dreadnaught 1000 is of classical complementary symmetry circuit design using ten 20-amp epi base power transistors in each output channel. Although the NPN and PNP complementary power devices used in the Dreadnaught 1000 are considerably more expensive than the single diffused NPN transistors used in other super amps, the manufacturer claims that advantages in speed, bandwidth, reduction of crossover distortion, and reduced power-dissipation at idle are worth the additional expense.



# COMPLIMITER™



## MODEL 610

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Electrical performance is exemplary, as one would expect of a fully professional product in its price range, including worst case harmonic distortion of 0.25% with 0.025% typical; worst case IM of 0.1% with 0.025% typical; slew rate in excess of 25 volts per microsecond; signal to noise ratio of 100dB; and frequency response at 250 watts per channel into 8 ohms of 20 to 20,000Hz +0.5dB, -0dB.

The amplifier weighs 80 pounds, measures 19"W x 7"H x 15"D, and is normally supplied without case for rack,



shelf, or custom installation. A walnut wood case is available as an accessory at a price of \$80.00.

Price of Dreadnaught 1000 - \$1,299.00  
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Circle No. 159

**dbx ANNOUNCES ADD-ON NOISE REDUCTION FOR NAGRA IV-S**

A direct bolt-on professional noise reduction package designed by dbx for the \*Nagra IV-S portable stereo tape recorder is said to permit the already excellent Nagra unit to produce master tapes on location which have a signal-to-noise ratio surpassing that of the most expensive studio recorders using other noise reduction systems.

The dbx 192 is a two channel switchable record or playback system identical in performance to dbx studio noise reduction systems. It combines 30dB of broadband noise reduction with a 10dB increase in tape recorder headroom, requires no level matching, and contains only one control, a record/play switch.

The accessory package is slightly over one inch thick and bolts directly to existing tapped holes in the Nagra case using hardware supplied. The dbx 192 is designed without an independent power supply to keep weight to a minimum. Its one-third watt power requirement is taken

from the Nagra supply. A single seven-pin DIN conductor and cable is supplied to mate with the Nagra noise reduction connector.

The dbx 192 is built to survive the rigors of location recording, including 1/8" thick anodized aluminum case, computer grade glass epoxy circuit boards, metal cased, hermetically sealed semiconductors and integrated circuits. The unit is available from dbx dealers or the factory for \$600.00.

\*Nagra is a trade mark of Kudelski, S.A. of Switzerland.

dbx, INCORPORATED, 296 NEWTON ST., WALTHAM, MASS. 02154, (617) 899-8090.

Circle No. 160

**MODULAR AUDIO PRODUCTS INTRODUCES NEW CONSOLE INPUT MODULE**

Known as the MAP Model 8422, the new console input module features a low noise microphone preamplifier with an equivalent input noise of less than -129dBm. Other features include a peak

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Model 8422 uses high quality component, such as the MAP 1731A operational amplifier for low noise, low distortion, high output level and high reliability.

This compact unit measures 14"L x 1.5"W x 6"D. Price is \$550.00 each and delivery is stock to 60 days.

**MODULAR AUDIO PRODUCTS, INC., 1385 LAKELAND AVENUE, BOHEMIA, NY 11716. TEL: (516) 567-9620.**

Circle No. 161

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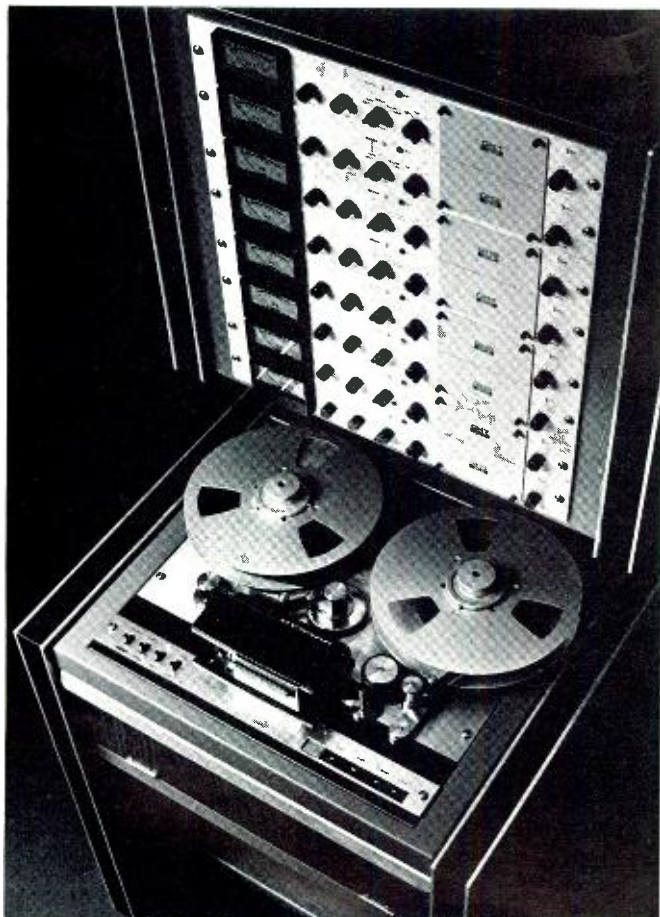
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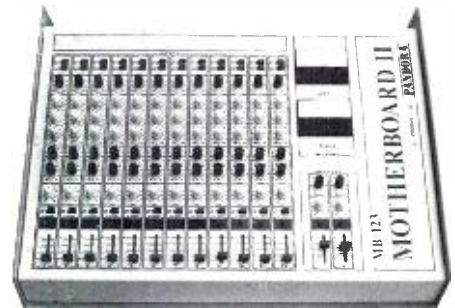


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IT HAD TO BE GOOD

but when he announces the production of a console  
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IT HAS TO BE THE BEST

It's been five years since I began the active design phase of a project that was destined to almost revolutionize recording consoles. In July of 1971, I entered into a long term agreement with MCI Recording Equipment, Inc. of Fort Lauderdale, Florida, whereby they would lease that console design from me on a royalty basis. In September of 1971, the first of the MCI JH-416 consoles was delivered to Warner Brothers "Amigo" Studios in Hollywood through Westlake Audio. The console now carries a new model number, the MCI JH-428, and is in my opinion, still one of the best available values in basic multi-track consoles.

The reason for its past and current success is that it was conceived out of need. In 1970, there were no mass produced "Stock" consoles for multi-track recording; in 1970, there were no consoles available that had been specifically designed for multi-track recording from the ground up; and in 1970, you could not buy a high performance 16 buss console for under \$20,000, delivered and installed.

It's five years' later now, and the state of the recording art has advanced tremendously. Recorded product must be acceptable to a much more sophisticated audience today. They are aware of good songs, good artists, good mixes, and creative manipulation of recorded sound. This awareness has placed tremendous pressures on today's writers, artists, musicians, producers, and mixers. This pressure extends into all areas of reproduced sound.

People in studios have thus become more sophisticated and have placed new demands on the physical plant. Studio acoustics have been improved, control room acoustics are designed to relate well to a typical listening environment, monitor systems are designed to deliver good sound pressure levels with excellent linearity, tape manufacturers have introduced new stock, machines manufacturers have given us 24 track machines with full servo transports and improved signal processing electronics. Peripheral designers have given us toys and tools to help create the best possible final product from that initial studio performance. Automation (memory mixing) frees us from many redundant mixing chores so that we can be more creative in our application of this new technology.

**The recording console is the operational and signal flow center of any recording studio.  
All devices connect directly or indirectly to it and the performance of  
the studio itself can be no better than the performance of the console.**

Clearly there is a need today for a new recording console. One that will allow all of our new found technology to be used to the fullest. A console that takes full advantage of the best electronic methods available today to deliver uncompromising reliability in service, with signal handling characteristics unavailable until now as to noise, distortion, and all the other number related specifications.

Even more clearly, there is a need for a console that while tremendously increasing the flexibility and options available to the operating personnel, should remain simple enough to operate, so that we are able to channel our best talents into the creative use of these advanced facilities.

Does that sound like a dream? It has been mine for almost two years. After much work by myself and others, I take pride in announcing the introduction of the Harrison 3232 master recording console at the Audio Engineering Society Convention beginning October 31, 1975. This first console will be deliverable before the end of November. Production will commence immediately with two consoles per month scheduled for 1976.

This recording console bears my name because I am proud of it. It is being manufactured in Nashville because that is my home. I am personally supervising the construction, testing, and acceptance of each system. Not that someone else couldn't probably do it as well, it's just that if it is to carry my name, I must be certain that each and every console is exactly what it was intended to be, the finest most reliable recording console ever offered to the industry.

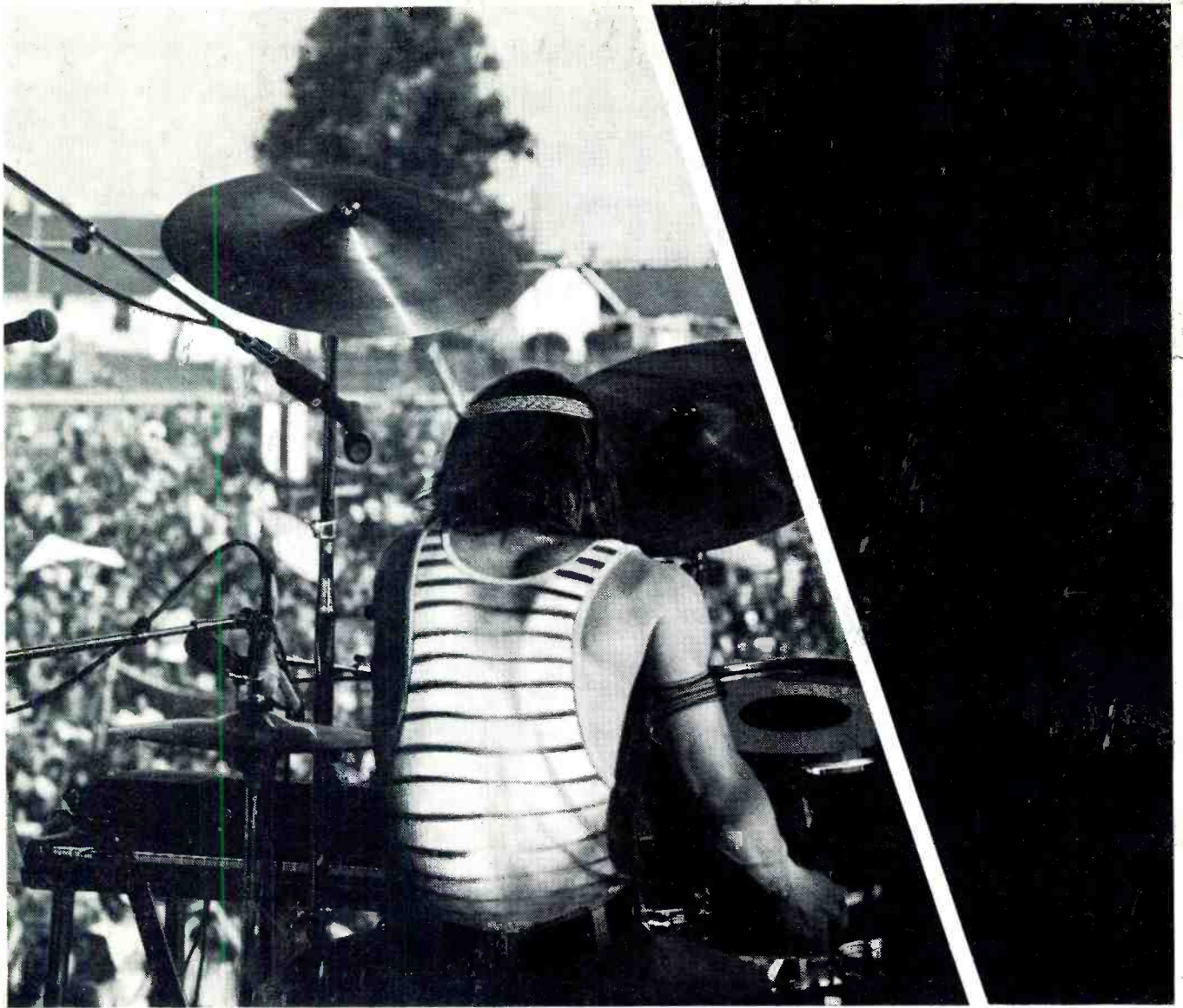
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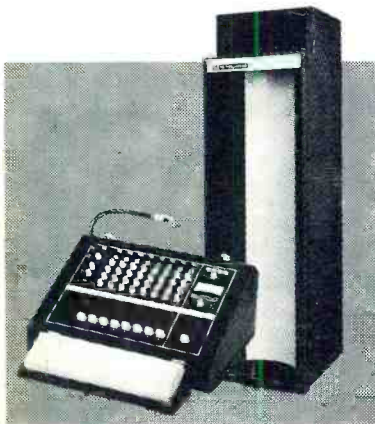
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