

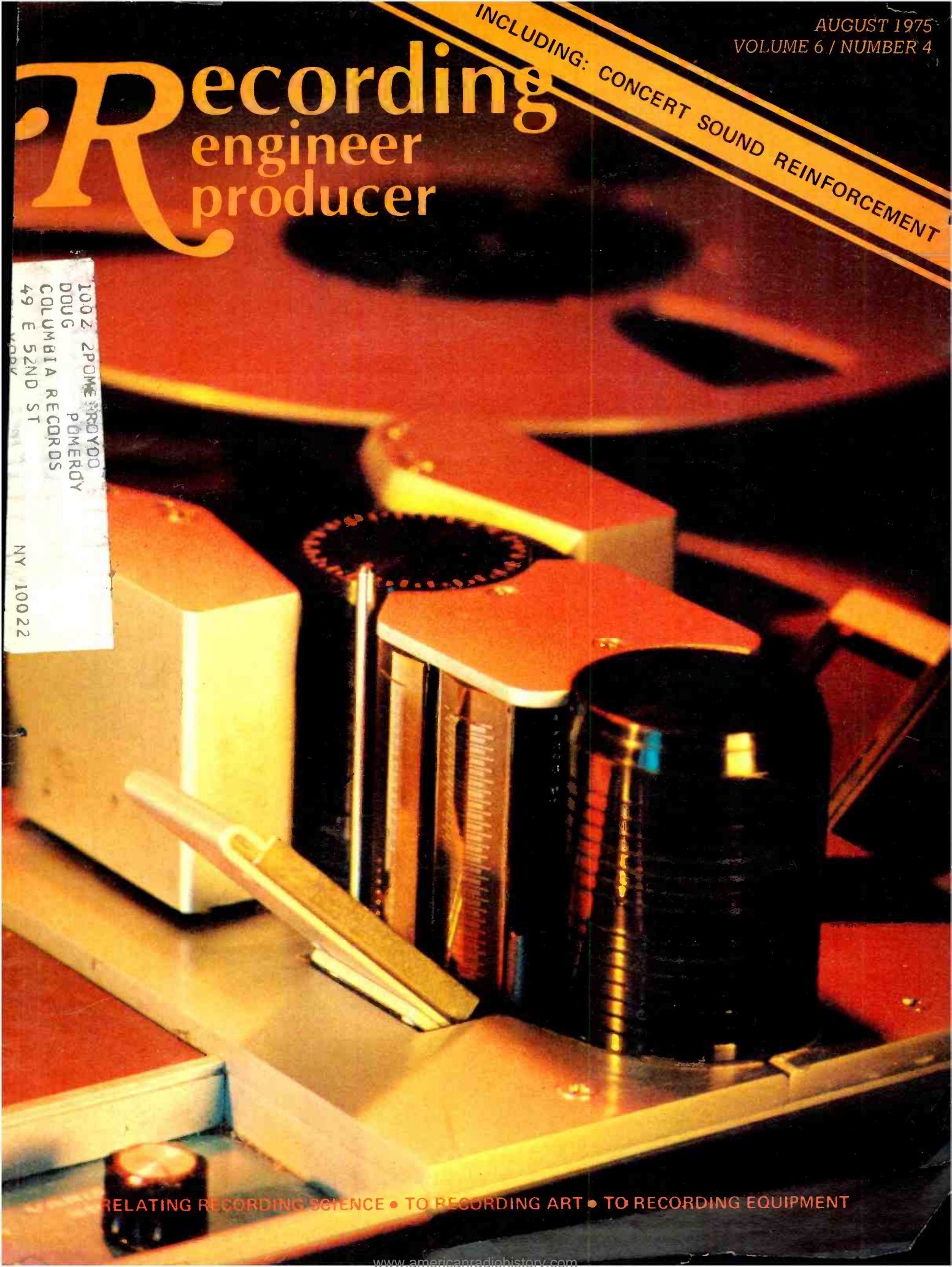
AUGUST 1975
VOLUME 6 / NUMBER 4

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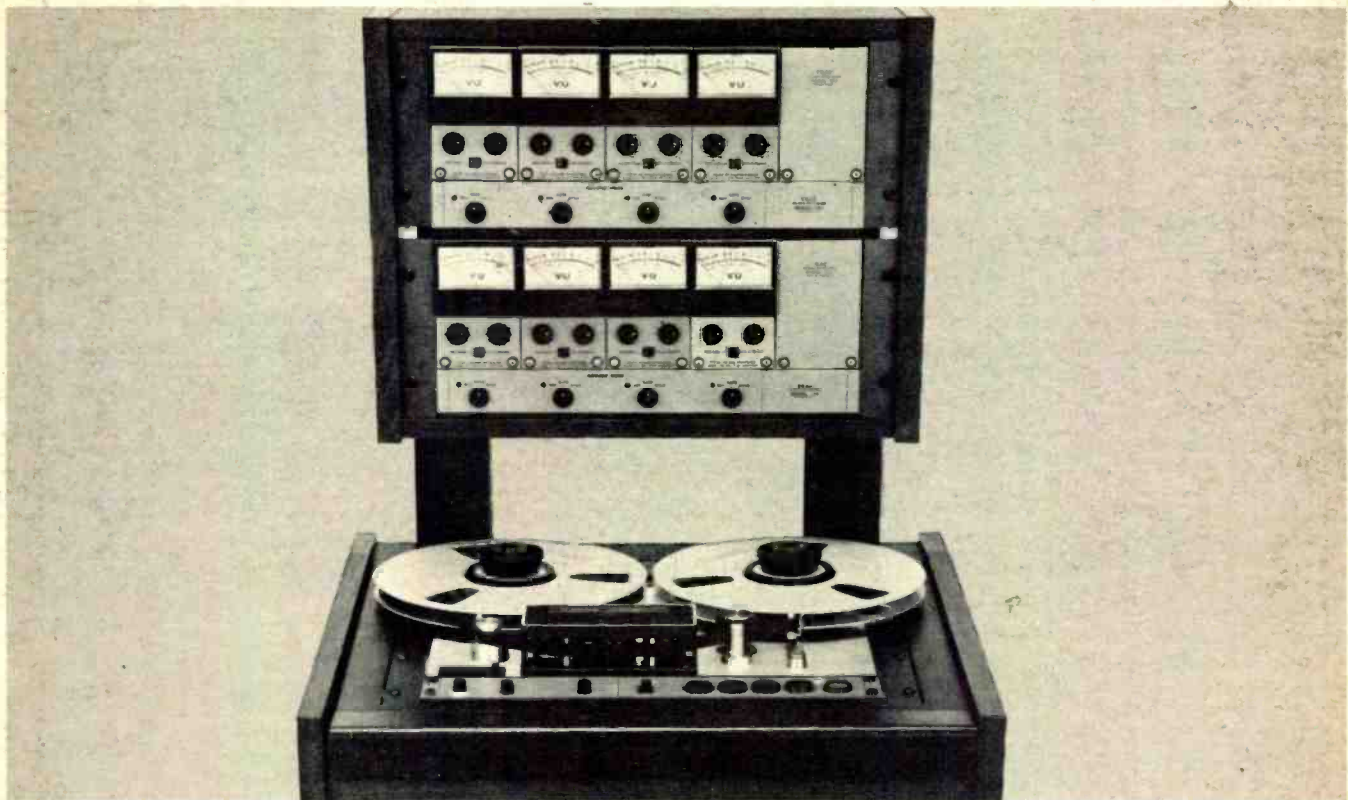
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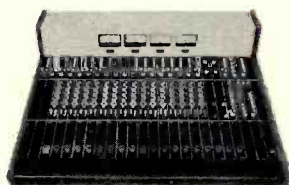
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GRANDSON 36 inputs
18 mixing positions

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RECORDING engineer/producer

— 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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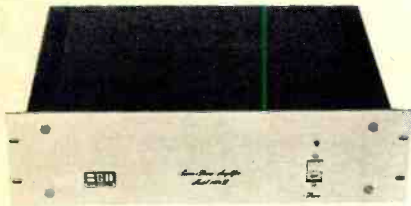
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THE BGW 250B DOESN'T HAVE—

- Fuses
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- Hum
- Noise
- Thumps
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- Mono-stereo switch

*Guaranteed specifications:

Stereo mode: 90-watts/channel into 8-ohms, 20-Hz-20-kHz with less than .1% total harmonic distortion (THD).
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Mono mode: 180-watts into 16-ohms, 20-Hz-20-kHz with less than .1% THD.
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Letters & Late News

FROM: Philip V. Blakely
 United Audio Recording
 San Antonio, Texas

"5 A.M. REFLECTIONS"

Thinking back over the years now, I wonder if it wasn't a better time. There was an excitement then. Well, excitement is not quite the word. It was more like a great purpose. I saw myself as a great crusader of sorts, a man with a mission. To capture on a thin slice of tape, a quarter inch of plastic and powdered iron, the talent of man. Perhaps a bit melodramatic, but that was and I guess still is the way I feel.

To launch this great adventure we (a good friend and I, we both worked at the same radio station) rented a small house in a not so exclusive part of town, and began to modify it. It had three bedrooms, two of which were used as living quarters and the third was converted into an echo chamber. Well, converted is not quite accurate. Actually the house had hard wood floors and no furniture so the addition of a speaker, a pillow, and a microphone was all that was needed. Now you may be asking yourself, what's the pillow for. Well, it's hard to freely give out such valued information, but the pillow was the room equalizer. Strategically placed in front of the mid-frequency horn it would give the correct balance to the room. The kitchen was master control. Master control smelled funny. My partner seemed to have an endless supply of pinto beans simmering on the stove. (I didn't complain though, I like pinto beans.) We constructed a small wall between the kitchen and livingroom with a double glass window, so as to look as professional as possible, and a small opening in the corner for wires. The livingroom was studio A. Searching around town we managed to find a shipment of water damaged carpet which we layed, double thick, on the floor to soak up a bit of sound.

The equipment in our pinto bean control room was actually quite impressive compared to its surroundings. We had one each Ampex 440 four track, the pride of the company, an eight channel mixer with low and high frequency shelving, a couple of Shure mixers and a rather wide variety of inexpensive mikes. Inexpensive by most people's standards that is. Monitoring was done through a single Seaburg discotheque type speaker.

Well, you know what they say about women and equipment, it ain't what you got, it's how you use it. That was my philosophy, and has over the years proved

to be a good one. The four track was tuned to a razors edge before each session. Every interconnect was made with care as to phase and grounding, and the equipment was electronically perfect.

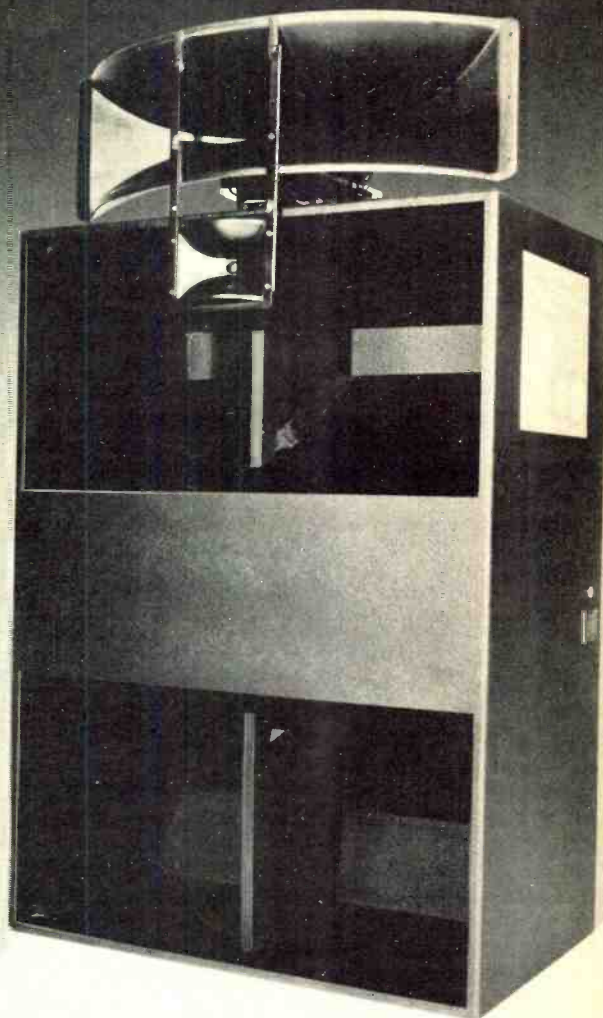
Everything was set so we got down to the business at hand and began to *make music*, and it was good. Good enough in fact to make me seriously wonder, why I am where I am. You see, at the moment I'm sitting behind a monstrous mass of digitized, computerized electronic hardware we like to call your normal everyday recording studio, and I'm wondering, why all this junk.

It seems for good reason. You see I've been playing a little game tonight. It's called, can you tell them apart, and here's how you play. You play tape "A" from long ago into your left ear and tape "B" from last night in your right ear and see what your left ear tells your right ear. In this case my left ear said, "what the hell did you buy all this equipment for?" I had to admit, tape "B" was not much better, if it was better at all. If this is the case, then there must be some other reason, and there is.

It all goes back to a decision that was made in the old house. The decision was to become recording *magnets* (sic. magnets), if you will excuse the pun, instead of happy go lucky rent house recorders, or falling short of that to at least become self-employed in the business, so we started to think about what we considered to be the ground rules that made up the magic formula of success. The first to go was the house because the first rule said you must have a regular business location if you want to be a regular business. The second rule came after we installed our equipment in the new shiney control room. You see, in the little kitchen it was impressive, but in the new location it looked like tinkertoysville. Rule two was formulated at that point to say, the client's confidence is primary, and to acquire this confidence you must have an impressive control room consisting of thousands of lights, meters, cable wire, patch cords poked into holes all over the room, huge speakers with enough power to blast everyone through the front door, and anything else that will astonish, amaze, and totally confuse (that's important) anyone who walks in the door.

After struggling along for a while another rule was inspired by such comments as "say man, da last time I was inda big apple cuttin tracks they were usein this big wide tape, musta been two foot wide, a thousan or so tracks," and "Hea, where's the noise reducer segated triple track pump guard, everyones using one." The rule was to be competitive, and in order to be competitive you must be able to compress, expand, limit, equalize, phase, filter, echo, analyze, pasturize or homogenize any one portion of any one piece of audio in the place.

If you want to lay down
a 113 dB signal*
flat from 28 to 18,000 Hz,
radiating through an angle of 120°
the SENTRY™ III is it.



On the other hand,
if you need 4 dB more level
on axis, and are willing to
give up just 22 Hz of bass, consider
the SENTRY™ IVA.

*4' on axis with just 50 watts, with
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without equalizer, 40-18,000 Hz.

Both monitor systems share the same mid-range and high frequency speaker components. Both have tweeter protector circuits built in to save the systems from inadvertent damage. The Sentry IVA uses a dual-speaker, horn-loaded bass end for efficiency. The Sentry III uses a single speaker in

a vented enclosure for extended range.

Sentry III. Sentry IVA. The two best ways to recreate the actual sound pressure sensations and response range of live music... in the studio or in demanding sound reinforcement installations. From the innovators at E-V.

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Circle No. 108

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Being competitive didn't stop there though, the hand full of trusty little mikes gave way to an arsenal of Neumanns, all strategically placed so that any one not watching where they were going in the studio would catch one between the eyes, every two feet. The reliable little mixer was replaced by an ocean of knobs, buttons, switches, and lights that could be programmed to spell out Merry Christmas at midnight December 24, and of course the pride of the pinto bean kitchen, the finely tuned little four track was pushed aside to make room for a genuine imitation mahogany covered monster called tracks tracks and more tracks. None of which are finely tuned and very seldom roughly tuned because there is just not enough time.

So here I am. Sitting here at this ridiculous hour of the morning listening to tape "A" from the rent house and tape "B" from last night and not being able to tell any great difference. But you know what, come to think of it there was a big difference. Tape "A" sold as a fine jingle and we opened a savings account. On the other hand, if we sell tape "B," another fine jingle, we may be able to catch up with last month's bills.

Oh well, I'm not really sitting here feeling sorry for myself for doing the wrong thing. As a matter of fact if I had it to do over again, I would probably end up sitting here surrounded by the very same equipment. Why, because that is the structure of things. That is to say, we are a long time past the days of Edison, and the recording industry has come to expect certain things from its so called successful people. *You grow that way or you don't grow at all.* Maybe some day the recording industry will turn around and take a realistic look at itself and realize you don't need a circus of equipment to make a good recording. Maybe some day they will realize that all you need is a small kitchen, or basement or whatever with a few pieces of good equipment, and some real talent on both sides of the double pane glass to put down good stuff. Maybe someday . . .

INFONICS HIGH-SPEED TAPE AND CASSETTE DUPLICATORS UNDER NEW OWNERSHIP

PHOENIX ENTERPRISE, INC. has acquired the assets of INFONICS, INC. from Electronic Associates, Inc. of New Jersey and has begun operations in Michigan City, Indiana, in a new manufacturing facility.

Paul Lloyd, Chairman of the Board of Phoenix Enterprise recently announced that Ross Terry, formerly Manufacturing Manager of the Video Products Group of Visual Educom of Michigan City, has been elected President of Infonics, Inc., and Carol Lant has been elected President of the Infonics subsidiary, Infonics International, Inc.



The complete line of Infonics quality tape and cassette duplicating equipment . . . reel-to-reel, reel-to-cassette, and cassette-to-cassette . . . will continue to be manufactured and distributed.

The Infonics System 200 offers quality cassette/tape duplicating. Reel and cassette masters and cassette slaves in many configurations . . . for large volume production.

D-8 and RR-Series duplicators produce multiple 8-track cartridge and reel-to-reel dupes for recording studios and professional duplicating firms.

The Model 102 Cassette Copier . . . for the office, school or library. Produces two superb C-30 cassette duplicates in one minute.

INFONICS, INC., P.O. BOX 1111, 238 HIGHWAY 212, MICHIGAN CITY, IN 46360.

MAJOR PROMOTIONS AT JBL

Sidney Harman, President of Harman International (parent company for JBL, Harman/Kardon and Tannoy) announced four major promotions among top management at JBL.

Arnold Wolf, President of JBL since 1970 has been promoted to Chairman of the Board of JBL. During his presidency, Mr. Wolf had primary responsibility for the visual design of JBL products, a role which is now expanded to include that responsibility throughout Harman International. Wolf's first association with JBL dates back to 1957. Then, as head of his own design firm, Arnold Wolf Associates, JBL commissioned him to create the visual design for the nine-foot wide Paragon loudspeaker, one of the several award-winning products he has designed for the company.

Sterling Sander, formerly an Executive Vice President at JBL replaces Arnold Wolf as President and Chief Executive Officer. His new role is an encompassing one; he is responsible for all operations at all levels of JBL Corporation president, Sidney Harman stated that Sander's promotion reflected the "superb job" he has done for the last five years as E.V.P.

I.R. Stern has been appointed a Vice President of Harman International, continuing his position as a Vice President at JBL, but expanding his role to include the U.S. marketing policies for the three high



SPECIFICATIONS FOR JH-120 AND JH-140

Frequency Response: Specifications referred to a 1 KHz zero reference recorded on Scotch type 206 or equivalent high-output low-noise tape.

Reproduce

30	In/Sec AES	± 2 db	50 Hz to 20 KHz
15	In/Sec NAB	± 1.5 db	30 Hz to 20 KHz
7.5	In/Sec NAB	± 1.5 db	25 Hz to 15 KHz
3.75	In/Sec NAB	± 1.5 db	25 Hz to 7 KHz

Record

30	In/Sec AES	± 2.5 db	50 Hz to 20 KHz
15	In/Sec NAB	± 2 db	30 Hz to 20 KHz
7.5	In/Sec NAB	± 2 db	25 Hz to 15 KHz
3.75	In/Sec NAB	± 2 db	25 Hz to 7 KHz

Signal to Noise: Unweighted signal to noise (30 Hz to 18 KHz RC filter). Reference to 250 nWb/m.

Reproduce

	Speed	Full Track	2 Track
30	In/Sec AES	67 db	66 db
15	In/Sec NAB	66 db	64 db
7.5	In/Sec NAB	65 db	63 db

Record: Less than 4 db added to bulk erased tape using Scotch type 206.

Flutter and Wow: Weighted peak flutter of recording and reproducing system using EMT 424 flutter meter.

30 In/Sec < .02% Din	7.5 In/Sec < .07% Din
15 In/Sec < .04% Din	3.75 In/Sec < .12% Din

Depth of Erase: Measured with H.P. 3581A wave analyzer set for 10 Hz bandwidth. Greater than 80 db below 250 nWb/m @ 500 Hz.

Distortion Off Of Tape: Measured with Crown IMA distortion analyzer using 3M type 206 tape at 15 I.P.S. Less than 1.5% at 500 nWb/m.

Electronics Distortion: Less than .1% THD at 1 KHz using H.P. distortion analyzer @ +23 dbm. Less than 2% IM (4:1) using Crown IMA @ +20 dbm.

Input

Line: Level -15 to +24 dbm for 0 VU. Impedance 10K balanced.

Mike Preamp Option: Level -60 to -20 dbm for 0 VU. Impedance 200 Ohm.

Output: Level +4 dbm at 0 VU. Source impedance 50 Ohm balanced. Maximum output +24 dbm at clipping.

Record Headroom: Greater than 20 db at 1 KHz, 15 I.P.S.

Equalization: 3 Speed NAB/CCIR (IEC) for 3¾, 7½, and 15 I.P.S. AES for 30 I.P.S.

Tape Width and Channels

JH-110 ¼" Full Track JH-140 ½" 4 Track
JH-120 ¼" 2 Track ¼" ¼ Track Optional.
Also, 4th Head Option Available

Reel Size: 3" to 11¾" EIA or NAB, plastic or metal.

Tape Tension: 3½ oz, supply and take up servo controlled. Constant all speeds and reel sizes.

Edit Capability: Paper basket (tape dump) mode—using EDIT button. Hand spool mode—(low brake force) automatically in STOP.

Start Time: 5 Seconds or less, @ 15 I.P.S.

Wind Time: 2400' of tape less than 90 sec.

Capstan Drive: Phase locked D.C. speed variable 5 to 45 I.P.S. or 2 to 22 I.P.S. dependent on machine fixed speed selection. crystal controlled.

Power Requirement: 100V-220V selectable, 50-60 Hz. Current requirement for 120V operation, 4 amps.

Height	35"	Depth	26"
Width	25¼"	System Weight	190 Pounds

PLANNED PARENTHOOD



The engineers of MCI conceived this baby two and a half years ago: a quarter-inch and a half-inch recorder to be created from the newest technology.

Whichever baby we deliver—the JH-120 (1/4") or the JH-140 (1/2")—you're assured that it's a new design, not a remodeled version of a bigger recorder, not a patchwork of new technology fused with older, outdated technology.

MCI's new baby on the block invites you to compare its features. You'll agree it's a 190-pound bundle of joy.

MCI DEALERS:

Hollywood, Calif.—Audio Industries Corp.
Stamford, Conn.—Audio Techniques
Richardson, Tex.—Frontier Audio
South Pekin, Ill.—Milam Audio
San Diego, Calif.—Pacific Recorder & Engineering
Nashville, Tenn.—Studio Supply

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the little mother



dbx new 160 compressor/limiter

She's got a compression ratio you can set anywhere from 1:1 to infinity. And she's got a very low distortion figure even at high compression ratios. You can set her threshold from -38 to +12 dBm, and her two red LEDs let you know whether she's above or below threshold. Her meter range is from -40 to +20 dB, and you can set her meter zero at any line level between -10 and +10 dBm. Her illuminated meter is switchable to read input, output, or gain change.

She uses true RMS level detection, which you know is more reliable and accurate than other methods. Her dynamic range is enormous and her noise contribution practically negligible. Her output is automatically ground loop compensated and she is protected against turn-on and turn-off transients. She is beautifully packaged and small enough that you can take her with you wherever you go. Or you can bolt her into the rack where she'll give you a lifetime of faithful service.

You're going to love this little mother, especially when you learn her price. She costs only \$300.00, which is a lot less than you pay for those other mothers. She's available now at your dbx professional equipment dealer's. For complete spec information including the little mother's measurements, circle reader service card or contact:

See the little mother
at AES exhibit 15
or Hilton room 482.

dbx dbx, Incorporated
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Circle No. 106

fidelity companies in the corporation; JBL, Harman/Kardon, and Tannoy. Stern, a veteran of many years in the audio industry, has successfully headed JBL's Marketing division since his arrival in 1970.

Rod Bell, recently appointed as Vice President of JBL's Consumer Division has now been appointed to Vice President, Marketing. In his new position, he will be responsible for the marketing effort for each of JBL's three major divisions: Professional, Consumer and Export. Since his arrival at JBL in September of 1971, Bell was first a Regional Sales Manager, then a year later promoted to National Sales Manager.

'MORT' FUJII NEW 'G.M.' OF CETEC AUDIO

Cetec Corporation has announced the appointment of Mr. Wesley M. (Mort) Fujii as Vice-President and General Manager of its Cetec Audio Division. Mr. Fujii comes to Cetec from Electro Sound Inc., where he was Vice-President and General Manager. Other positions have included Vice-President of Bell Sound Studios and Manager for Ampex Corporation.

In his role as General Manager for Cetec Audio, Mr. Fujii will be responsible for the development of new product areas complementary to the Company's line of Gauss tape and cassette duplicators, Gauss professional loudspeakers and Cetec studio, broadcast and live media consoles.



Mr. Fujii is a graduate of Illinois Institute of Technology and a Fellow in the Audio Engineering Society, and has been active in the professional audio and magnetic recording industry for 20 years.

AUDIO DESIGNS - AMPEX SIGN INTERNATIONAL MARKETING PACT

Ampex Corporation today announced it has reached agreement with Audio Designs and Manufacturing, Inc. to distribute ADM stock and custom audio consoles and components to the international recording and broadcast industry.

The two-year marketing agreement gives Ampex exclusive distribution rights to international markets excluding Brazil. Detroit-based ADM will continue to market its products in the U.S.

C.V. Andersen, Ampex vice president — general manager of Ampex International, said the agreement was effective May 1, 1975.

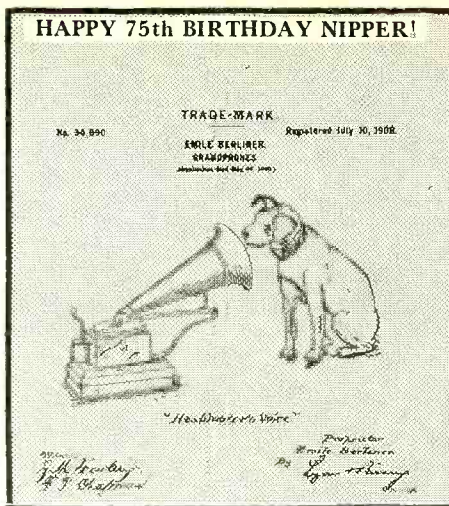
Under the agreement, Ampex now distributes the complete line of ADM consoles including the BC, TV and NRC series. All ADM products have a five-year warranty and offer such features as AUDEX switching and VUE-scan metering.

According to Robert Bloom, ADM president, "The agreement gives ADM the advantage of Ampex's worldwide marketing organization and will enhance our overall performance in domestic sales and promotion as well."

Founded in 1966, ADM manufactures audio components and custom consoles for radio and television broadcasters and recording production specialists. ADM consoles range in price from \$10,000 to \$125,000.

NORTRONICS RELEASES NEW AUDIO HEAD DESIGN DIGEST

The new 96 page book features an extensive technical section written by Nortronics engineers to answer frequently asked questions about magnetic head design, head applications, and circuit considerations for typical audio applications. It is aimed at helping engineers understand not only what results will occur under certain conditions, but also why they will occur.



The book also contains a bibliography of magnetic recording, covering both theory and practical applications.

The catalog section of the Design Digest covers the full range of standard audio heads from 24 channel, two inch studio heads through cassette heads for 0.150 inch tape. Also included are many special purpose heads such as those used with film stripe, drum recording, dictating belts, and for magnetic media other than tape. Another section of the book features accessories.

These features of the new Audio Design Digest contribute to its overall purpose of helping the engineer specify the best

possible head to fit his precise needs. The type and depth of information in this book make it a ready reference for audio engineers.

To obtain your personal copy of Nortronics' Audio Magnetic Head Design Digest, write **NORTRONICS OEM SALES DEPARTMENT, NORTRONICS COMPANY, INC., 8101 TENTH AVENUE N., MINNEAPOLIS, MN 55427.**

(When writing for these publications please mention that notice of their availability was seen in R-e/p.)

TEKTRONIX COOKBOOK OF STANDARD AUDIO TESTS AVAILABLE

The "Tektronix Cookbook of Standard Audio Tests" describes the use of a modern low frequency spectrum analyzer and a few associated instruments to make the important response and distortion measurements on an audio amplifier.

Ask for this 20-page book on your company letterhead. The "Audio Cookbook" illustrates 5L4N Spectrum Analyzer tests for power output, frequency response, harmonic distortion, intermodulation distortion, distortion vs output, power bandwidth, damping factor, signal-to-noise ratio, square-wave response, crosstalk, sensitivity, and transient intermodulation distortion.

TEKTRONIX, INC., P.O. BOX 500A, BEAVERTON, OR 97077.

The Sensual Equalizer.

Whether on record or in live performance, today's most commercially successful music is more visceral, immediate, and sensual than ever before. This impact has been achieved through advances in the musician's art, and through a quantum jump in the control available in audio processing.

The Orban/Parasound Parametric Equalizer, Model 621, has received outstanding acceptance since its introduction because it combines economy (\$340/channel) with extraordinary control. Each of its four non-interacting bands permits continuous, stepless adjustment of bandwidth, equalization, and center frequency. Each band can be tuned over a 20:1 frequency range with no change in curve shape (unlike some competitors), and peak gain remains constant as the bandwidth is varied. The unique "constant-Q" equalization characteristic is more musical than the usual reciprocal curves, and lets the equalizer create infinite-depth dips to remove hum, whistles and ring modes — making it ideal for cinema and sound reinforcement as well as recording studio and

broadcast applications. Other outstandingly useful features include a front-panel gain control and a peak-stretching overload lamp which indicates clipping anywhere in the equalizer circuitry.

While our spec sheet (available from the address below) gives the details in cold black-and-white, it cannot describe the sensual interaction between man and machine which occurs when the frustrating limitations of conventional equalizers are finally overcome, and the user is given the power to create sound that feels really right. Our ability to deliver this power at an affordable price is the true reason for the O/P Parametric's success. But don't take our word for it — discover the Sensual Equalizer for yourself, soon.

For further information, contact

orban/parasound

680 Beach St.
San Francisco Ca. 94109
Or contact your local
Orban/Parasound distributor



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.

Presenting the Yamaha PM-1000 16 x 4 mixing console.

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.

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TROUBLESHOOTING AN AUDIO SYSTEM WITHOUT TEST EQUIPMENT



by EDWARD S. JONES
Supervisor, Sound Reinforcement
Brigham Young University
Provo, Utah

A few years ago, the author was trying to justify to a personnel department a wage increase for the sound department's operating technicians. In order for the wage increase to be approved, it would have to be shown that the operating technicians required special technical skills and training. The personnel man, who was not technically oriented himself, had just approved a raise for the bench service technicians because "they knew how to operate oscilloscopes, oscillators, and distortion analysers!" When he asked if the operating technicians worked with complicated equipment such as this he was told that the operator often had to troubleshoot and repair a system with no more test equipment available than a screwdriver and a wet finger. The bench technician will occasionally be under the gun because his boss is watching, but the operator often must diagnose and fix his system with an audience of thousands

watching, wondering why the sound system went dead. A few in the audience and most of the top management present already know... "That idiot in the sound booth fell asleep at the switches."

Now, before the technicians in our maintenance department get the wrong idea from reading this and fill my earphones with honey, let me state that the purpose of this article is not to say that the operating technician is smarter than the maintenance technician. Each requires a particular skill. This article will describe some of the methods used in troubleshooting a sound system with a minimum of test equipment. These will include both those techniques used during a program and beforehand during set up.

Because of budget and lack of space the sound technician on the road rarely has the kind of test equipment found in a service shop, but he does have many resources available that can be used in troubleshooting the system. The most

valuable item in troubleshooting is a block diagram of the complete system. Using this, along with logic and intuition, the soundman can often locate the problem by just observing the symptoms and never open a lid on an amplifier. The basic procedure of troubleshooting anything, be it an amplifier or a radio transmitter, is to start at the input of the device and follow the signal through until it stops. Where the signal stops is where the problem is. This may seem awfully basic, but some soundmen forget this when under the pressure of a program and they have been known to plow through the problem without analyzing the symptoms. One new inexperienced sound technician couldn't get any sound to come out the speaker cluster although he was able to monitor the microphone through earphones connected at the console output. Panicked because the program was to begin he frantically ran to the stage and replaced all the microphones.

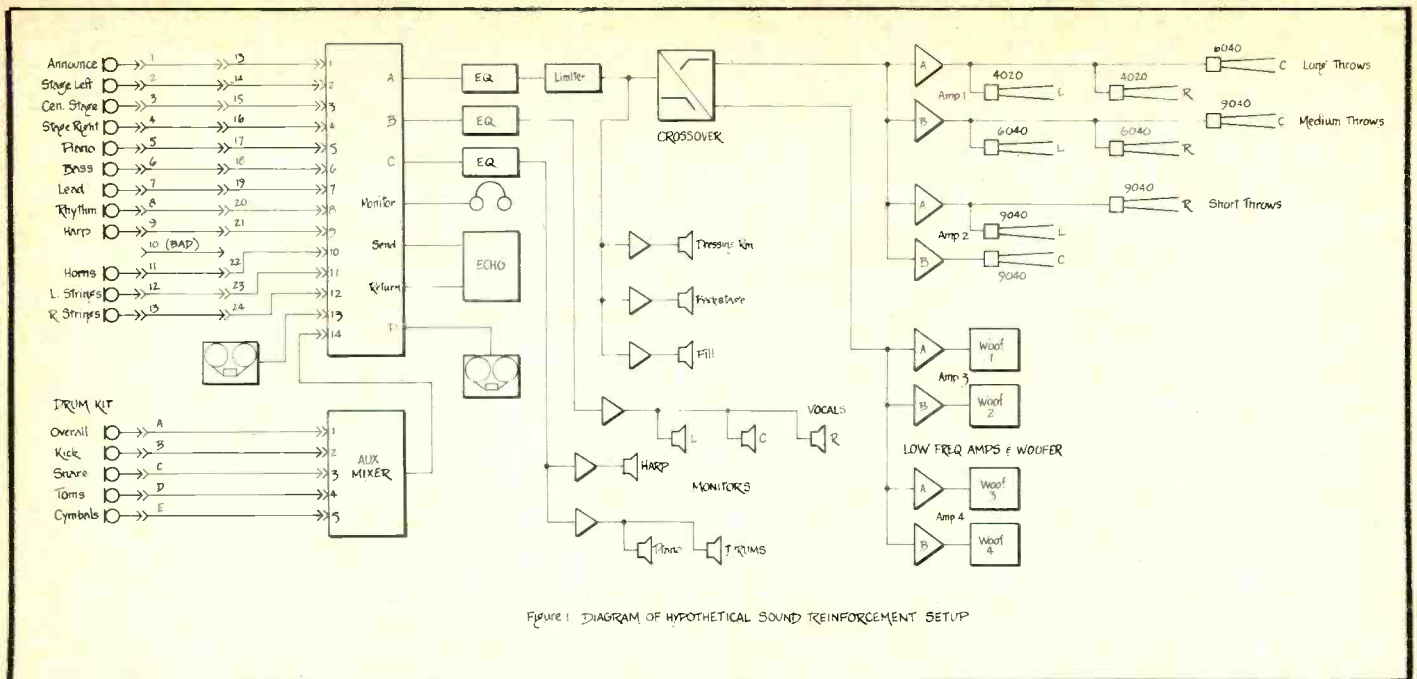


FIGURE 1. DIAGRAM OF HYPOTHETICAL SOUND REINFORCEMENT SETUP

Unless the system is extremely simple, you should draw out a block diagram of the complete system. Labeling on the drawing all the mike jacks, lines of the umbilical cords or snakes with the numbers found on them is especially valuable when tracking down problems.

Refer to Figure 1; a block diagram of a hypothetical sound system. If the main system loses all of the high end without even checking further, simple logic should tell you that there is a problem with either the crossover or the buss feeding the high frequency amplifiers. It is possible that all of the high frequency amps have blown all at once but *not very likely* . . . If the whole main cluster goes dead, some checking will be necessary to pin down the exact problem, but if you see that the meter is moving on channel A, logic will tell you to look after the console for the problem. If you had problems with the limiter the night before, intuition would cause you to suspect it over any other item, so it would be best to patch around it even before you begin to monitor the rest of the signal path using standard troubleshooting procedures.

Swapping parts is a good method of troubleshooting as long as you keep track of what you are doing. Here a block diagram is invaluable. If all the mikes work except the piano mike, the problem could be in a number of places — the mike itself, its cord, snake line 5, snake line 17 or input module No. 5. If the bass mike works when line 18 is plugged into input 5 (assuming that the snake has separate connectors for each line rather than a multi-pin connector), you will have eliminated the input module as the culprit. You then would go back and plug line 5 into line 18 to see if perhaps 18 is bad. If it doesn't work this way, you go further back and swap the mikes at lines 5 and 6. Now the piano mike works, but the bass doesn't so you know that line 18 is bad . . . or is it 17? Did we restore 6 to 18 and 5 to 17? The stage lights have all gone off now so that the light crew can set lights so maybe we had better just ask the piano player and the bass player to play loud. The point is, swapping lines or equipment to locate a problem is a legitimate way of troubleshooting, but it is easy to get confused if you are not methodical in your swapping. Each time you make a swap, draw a conclusion from the results and then decide what the next swap is going to be. Before you make the swap, determine what the possible results

will be and what conclusion will be drawn from each result.

The proper way to go after plugging line 18 into input 5 is to look at the diagram and conclude that the problem is in either line 17, line 5, the mike cord, or the piano mike. Restore the connections at the console and go back to where 5 plugs into 17, and plug 6 into 17. If the bass mike works through input 5 in this configuration you will know that line 17 is OK, and you will need to check further. If it doesn't, then you know 17 is bad. And so on.

When checking a chain of components like this, some soundmen start at the left and work to the right and others start at the other end and work back. Actually, you will save time if you start in the middle. In the chain of amplifiers in figure 2, checking point 5, then 4, then 3, and so on back to 1 will take six tries to find the bad amp, assuming the worst case where the last amp checked is the bad one. If you start at 3 and depending on what you find, you work either to left or to the right, it will only take a maximum of three tries.

When troubleshooting on the bench, the service man may use an oscillator as a signal source and track the signal down with an oscilloscope, VTVM, or perhaps an amplifier and speaker. The

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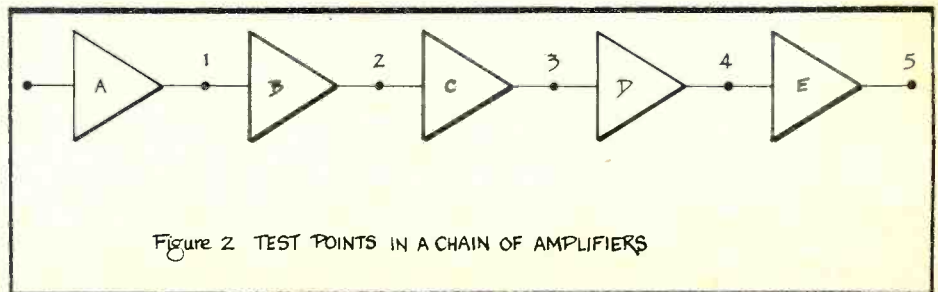
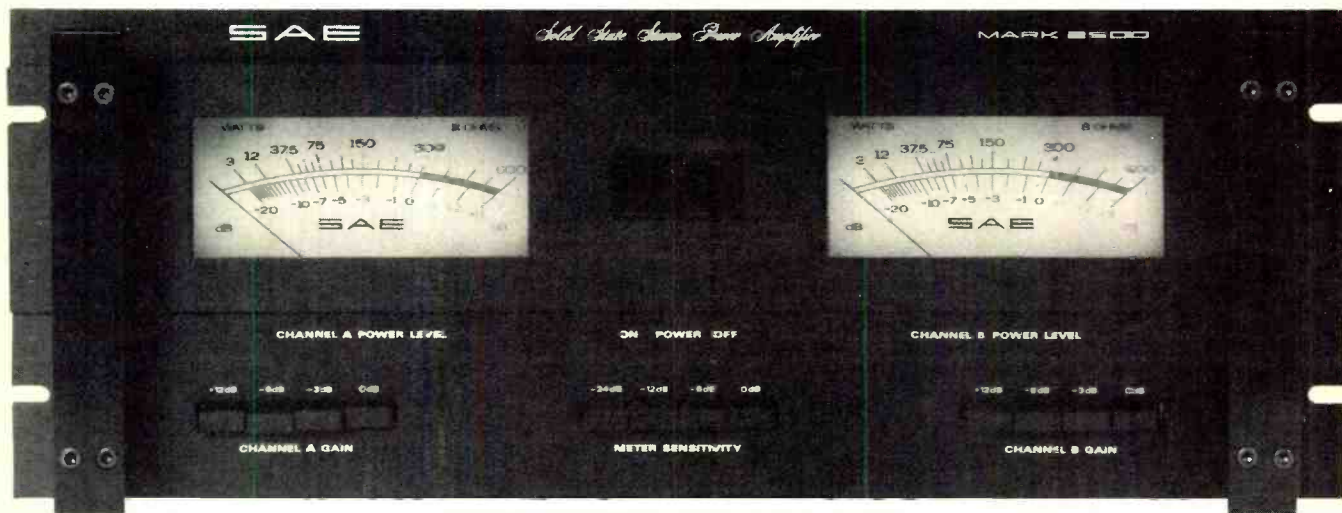


FIGURE 2. TEST POINTS IN A CHAIN OF AMPLIFIERS

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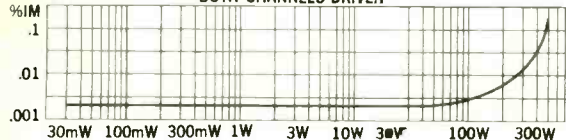
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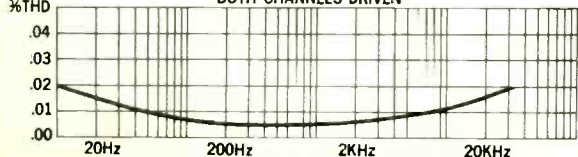
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operating technician, even if he is on the road, has equipment just as effective. Some signal sources are a mike with someone talking into it, the little battery-operated oscillators commercially available (yes, I know that's cheating because we said at the first that we don't have any test gear available but they sure make things easier), a wet finger touching the hot pin (No. 2 or No. 3) on the mike connector, a tape deck, an input run wide open so it's noisy, or a mike carried in your back pocket just for troubleshooting. One of the problems with touching the hot pin is that in most professional systems, the input is the female so you will need some type of probe to get to it, such as a piece of solder, paper clip, or the filler in your ball point pen. An excellent signal generator is an FM radio which when tuned to a good station can be used as a program source for checking quality. If it is tuned off station and the squelch defeated, it can be used as a white noise source for checking speaker distribution. You should be careful not to drive the system too hard, as it is a rather brutal signal for the loudspeakers to reproduce, and can burn out drivers.

Regardless of the type of source used, be sure that it is a reliable signal. If you are looking for an intermittent, the signal source must be absolutely constant. If you are making a quality check on the system the source must be good and also

familiar to the sound technician so that he knows how it should sound. Every soundman should have a tape or two that he has listened to over a high quality monitor to use in checking out a system.

Instead of an oscilloscope, there are other things you can use to trace the signal with. The VU meter on the console can tell a lot. If it is moving, it is an indication of a signal being present at the point. If it is modulated as if a signal is present, but does not return to the left stop when the signal stops, rather it rests on -10 for example, it probably means there is hum present. If it pegs without any signal being audible, then you had better shut down quick because that is a good indication of the system being in super-sonic oscillation. VU meters on the outputs of home stereo amplifiers are in most cases so much eyewash, but in a professional application they are a legitimate and valuable troubleshooting device. If the system has VU meters at the console, at the limiter, and on the power amp outputs, the operator may be able to tell at a glance where a malfunction has occurred.

Another valuable indicator that is often ignored as a test instrument is the simple pilot light. It may sound elementary, but checking the pilot lights when the system goes dead may save you a lot of signal tracing if the problem is due to power interruption. If the pilot light is a neon, it

may also indicate under some conditions if the primary power line is overloaded or supplying abnormally low voltage indicated by flickering, especially when the flickering is modulated by the audio under high output levels. Depending on how well regulated the power supply is in the power amplifiers, low AC supply voltage can cause the amplifier to distort at a lower power level.

Unfortunately, some audio equipment is manufactured without a pilot light and most equipment uses a 110-volt lamp connected across the input to the DC power supply as in figure 3A. Some are wired as in figure 3B which doesn't even indicate a blown fuse. Figure 3C is better because it indicates that the power supply in the amplifier is operating. A bi-polar supply should have two lights. Ideally, all equipment would have pilot lights as shown in figure 3D, where D1 indicates that the ON-OFF switch is ON and that the amplifier is receiving AC voltage. D2 indicates that the DC power supply is operating and if you want to really go all out, adding a light (D3) in parallel with the fuse will show when the fuse is blown.

What was said about the reliability of the source should also be said about the signal tracer as well. Even though an amplifier will work with a burned-out pilot light, it should be a firm rule to replace all burned-out bulbs.

Using a set of earphones is an excellent

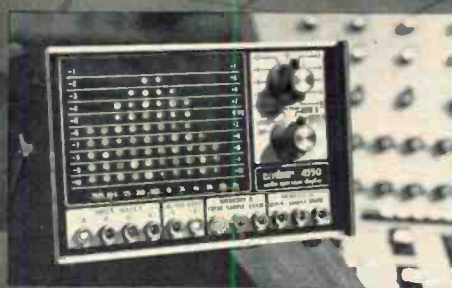
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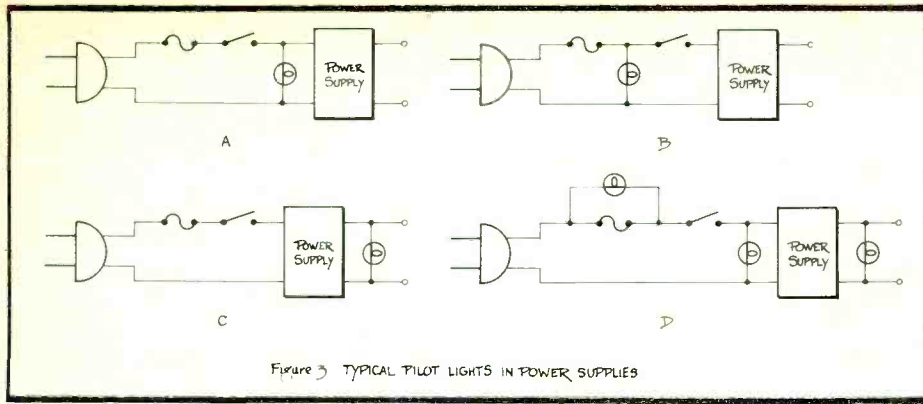


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way of audibly tracing a signal, but sometimes they are not available. A dynamic mike will work just fine as an earphone as long as you don't zap it with too high a signal. If it is connected directly to another mike and you listen closely you can monitor that mike's output.

A speaker can also serve to trace a signal, even in line level circuits; it just won't be very loud. If you are monitoring power amp outputs in a bi-amped system, it is better to use the woofer if you are not sure that each amp is being fed the proper signal from the crossover. The high frequency portion of the program, unless unusually high level, will not damage the woofer, but the low frequency portion of the program even at moderate levels may cause over-exursion of the

voice coil, rupturing the diaphragm.

There are some other methods of troubleshooting a sound system that are rather crude but effective. Sometimes a healthy pounding on the faceplate will cause an intermittent to show up and many times a well directed kick will revive an amplifier that has died during an important program when it is impossible to replace it. If a connector is in the slightest way suspected, it is quicker to shake it and move the cord sharply and listen for the audio to cut in and out than use the signal tracing methods described above.

Another help to saving time in troubleshooting, especially during a program, is to be aware of the probability of failure for each unit in the system. While any-

thing can malfunction in a system, the experienced sound technician knows that some items are more prone to failure and will check them first when the system goes down. Generally the following are the most vulnerable and are listed in order of unreliability:

1. Connectors
2. Cables, especially near the connectors where they are flexed the most.
3. Primary power source. (Plugs pulled out, circuit breakers tripped, a "constant" circuit that turns out to be a "dimmed" circuit on stage, etc.).
4. Loudspeakers (blown drivers, etc.)
5. Electronic equipment
6. Microphones

The order may be different for a particular system, but this is generally true.

CONCLUSION: In summary, the following rules for troubleshooting a sound system are presented:

1. Make a block diagram for the system and use it when troubleshooting.
2. Take advantage of intuition and previous experience with failures of the equipment.
3. Draw a conclusion each time something is checked instead of wildly changing connections.
4. Use a reliable signal source and a reliable signal tracer.
5. Check first the components that are the most prone to failure.

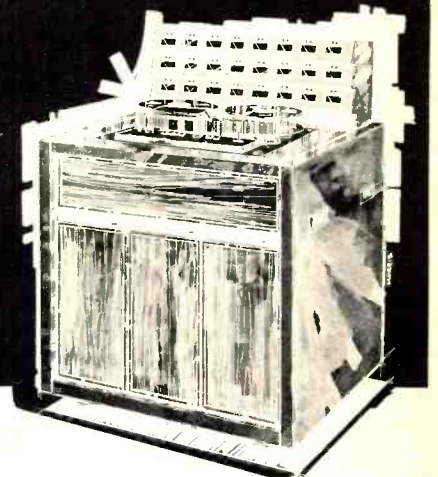
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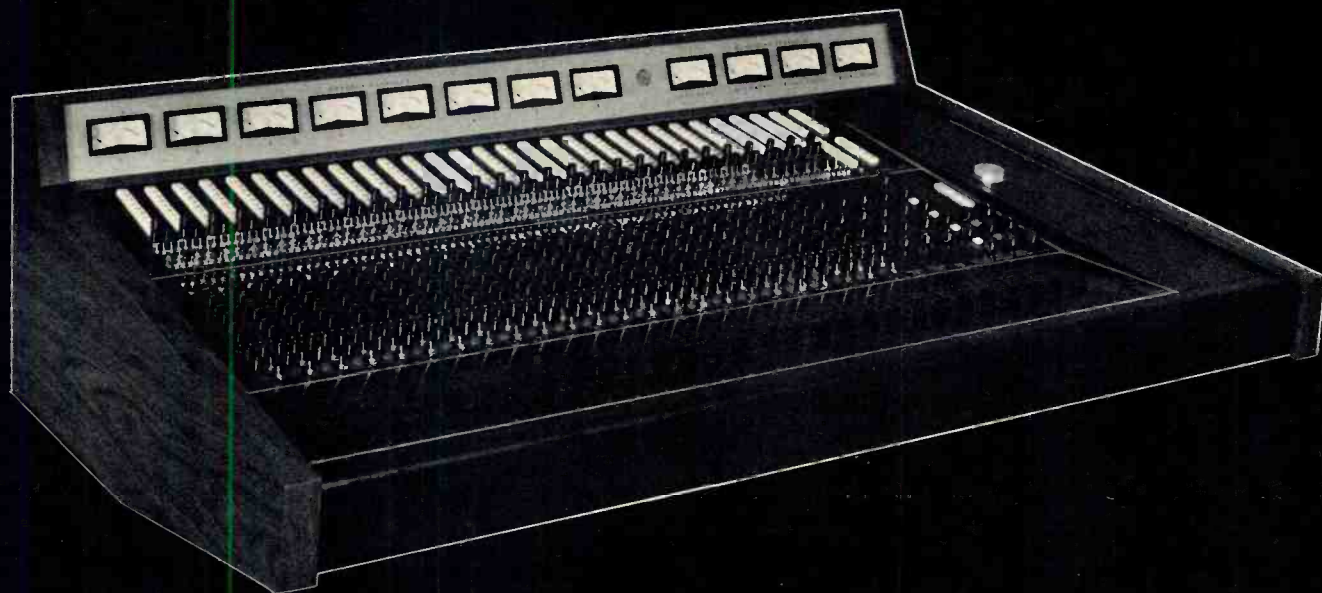


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It can be frustrating to the producing engineer when he reads about elaborately equipped studios with 16, 24 or even interlocked 16-track machines, and he knows that he has only four tracks to work with. The question is, then, how to use the four tracks available most efficiently . . .

Getting More On Four

by JAY PETACH, Audiocraft Recording, Cincinnati, Ohio and Fultz Recording Studio, Fairdale, Kentucky

Having worked in the profession for over three years (most of that time in a four-track studio), I recently learned of a technique that may be helpful. The technique requires only a 4-track and a second machine and is especially suited to short pieces of music where the desired final mix is mono. The basic idea is that the various sections, i.e. rhythm, horns, strings, etc., are recorded on separate pieces of tape and the mixed subgroups or submixes are resynced on one piece of 4-track tape.

Take the case of a typical 60-second commercial jingle with a four-piece rhythm section, horns, strings, and vocals. Today in this country a production of this type would normally be recorded on 16 tracks or more. The producer can therefore remain noncommittal about the final mix until it is actually done. In other words, no premixing needs to occur. The strings would be by themselves on the string tracks, the horns would be by themselves on the horn tracks, and generally there would be enough tracks to overdub or double the various sections for a bigger sound. (See Fig. 1). In the typical 4-track situation

this is certainly not the case. If the producer feels that doubling is necessary it is generally at the expense of "ping-ponging" or premixing the various sections together. However, with this resync technique the various sections may be overdubbed, and in the final mix the mixer will have individual control over each section.

First the rhythm track is recorded. (See Fig. 2). Next, and before any submixing (the mono mixing of one particular section) occurs, approximately 20 to 40 seconds of speech is spliced onto the head end of the rhythm track just ahead of the count. This speech will enable the different submixes to be resynced later. It should be noted that unless the machines to be used are servo-controlled the hub diameters should not be changed on the working reels. In other words, no tape should be added or removed from either the supply or the take-up reels on either machine. The addition or removal of tape could effect a speed change and make the submixes difficult or impossible to resync. A good practice is to leave the 4-track reels intact and to spool off about 900-1200 feet of 1/4" tape on a seven inch reel to be used for all the submixes. This will permit easy storage for the submixes in the event they are to be saved.

Figure 1. TYPICAL 16-TRACK COMMERCIAL JINGLE CHANNEL ASSIGNMENTS

Track	1.	PIANO
"	2.	BASS
"	3.	GUITAR
"	4.	BASS DRUM
"	5.	SNARE DRUM
"	6.	TOMS & CYMBALS
"	7.	HORNS
"	8.	HORNS
"	9.	HORNS
"	10.	HORNS
"	11.	STRINGS
"	12.	STRINGS
"	13.	STRINGS
"	14.	VOCALS
"	15.	VOCALS
"	16.	VOCALS

Figure 2. FOUR-TRACK CHANNEL ASSIGNMENT FOR RHYTHM SECTION

Track	1.	PIANO
"	2.	BASS
"	3.	GUITAR
"	4.	DRUMS

The next step is to mix the four piece rhythm section down to mono. Next, the mono rhythm track with the speech at the head end is dubbed several times onto the 4-track tape. The number of times will depend on the number of sections to be recorded. In this example the rhythm track is dubbed four times.

Next, record the various sections, one at a time. (See Fig. 3).

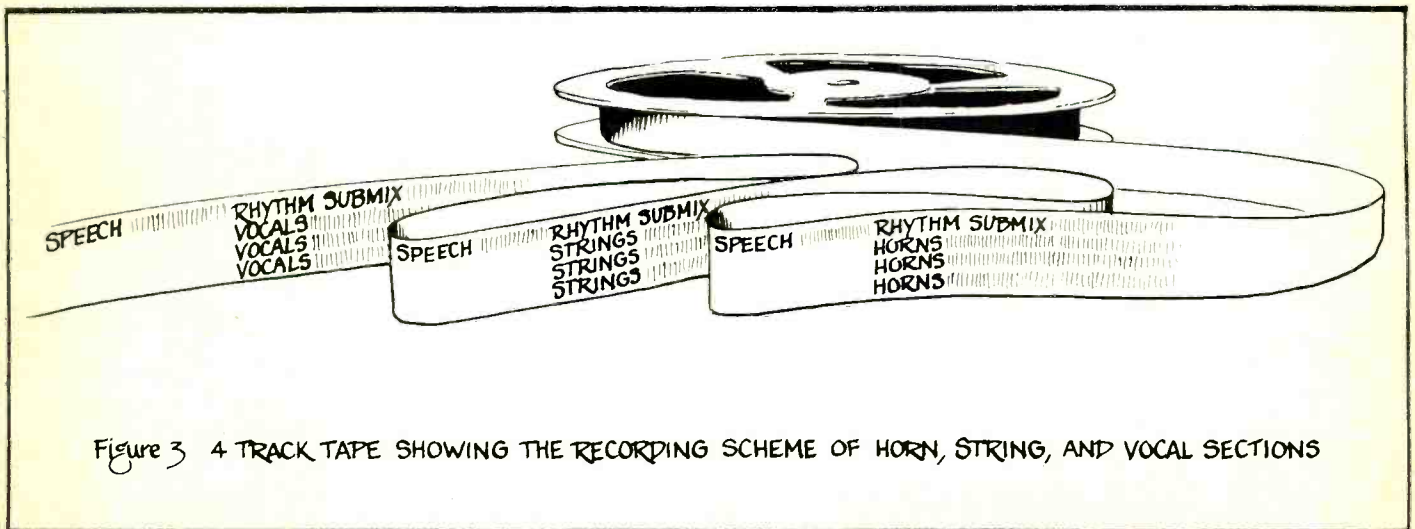


Figure 3. 4 TRACK TAPE SHOWING THE RECORDING SCHEME OF HORN, STRING, AND VOCAL SECTIONS

Finally each section with the speech at the head end is mixed to mono. This can either be done on a two track machine with the rhythm track going on one channel and the submix going on the other, or the submix can be recorded by itself on a full track machine. In the former case the producer has the advantage of hearing the submix played back with the rhythm track; in the latter the advantage is a higher signal-to-noise ratio.

Taking one submix at a time the first word of speech at the head end of the rhythm track on the 4-track is cued with the first word of speech at the head end of the submix. The two machines are then started simultaneously. At this point the two tracks will probably not be in sync, but they will be very close and will sound like a digital delay line. After determining which tape is ahead, a thumb is placed momentarily and lightly on the supply reel of the machine that is running ahead. This will cause a slight slippage of the tape between the capstan and the pressure roller and will bring the two tapes closer to being in sync. This procedure is repeated until the two reels are so close that a phase cancellation can be heard. This point is generally sufficient for the two tapes to be in sync. However, if the program material is such that a closer match is required, continue adjusting until only one signal is heard, or put the two channels out of phase on the monitor and keep adjusting until the speech cancels completely. When both tapes are in sync punch the 4-track into record and record the submix on the 4-track tape. Repeating the process, the other submixes are dubbed back to the 4-track so that the 4-track tape looks like Figure 4.

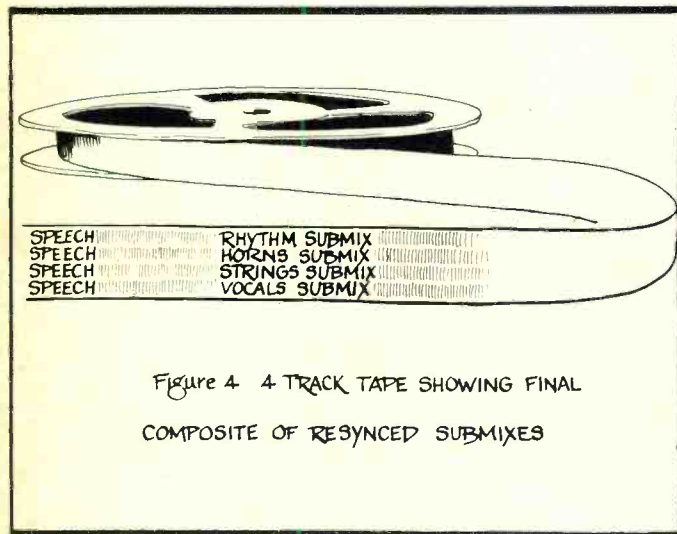


Figure 4 4 TRACK TAPE SHOWING FINAL COMPOSITE OF RESYNCD SUBMIXES

Although this procedure sounds complicated, it is quite simple and can generally be accomplished successfully in one or two attempts. Then, after the submixes are resynced, the tracks may be mixed in the conventional manner. If a decision is made that a particular section mix does not sound right, that particular submix can be remixed and resynced. If it is decided that the guitar should have been an electric guitar instead of an acoustic guitar on the original rhythm track the electric guitar can be recorded on the track where the acoustic guitar was previously recorded. The rhythm track can then be remixed (with the speech at the head) and resynced with the other submixes. In the latter case it should be noted that the new rhythm track and the other submixes can be assembled on another piece of tape and the original tape need not be erased, keeping all options open.

This method assumes that the tape machines used are stable with respect to speed and that no slippage occurs between the

capstan and the pressure roller, except when purposely causing slippage in adjusting for resync. This method also assumes that the production is short in length. Generally there is no problem with a 30 or 60-second piece of music. It is doubtful that many machines would hold sync in this manner for more than several minutes. It is also doubtful that producers who have access to 16-track machines and large production budgets are going to work on 4-track machines, but for the producer with a 4-track, a second machine, and lots of time, it's a great way to get more on four.

A Simple Panning Network

by WAYNE YENTIS

In spite of the growing number of commercially produced audio mixing consoles available to the recording and sound reinforcement industry, from the most elaborate to the less than \$500 variety, there remains a percentage of engineers and technicians who, for one reason or another, find occasion to design and build either a complete audio system or some special outboard controls for their existing equipment. If you are one of these people, you have probably needed or are going to need a flexible pan pot circuit, one that you can engineer to fit a variety of circuit requirements.

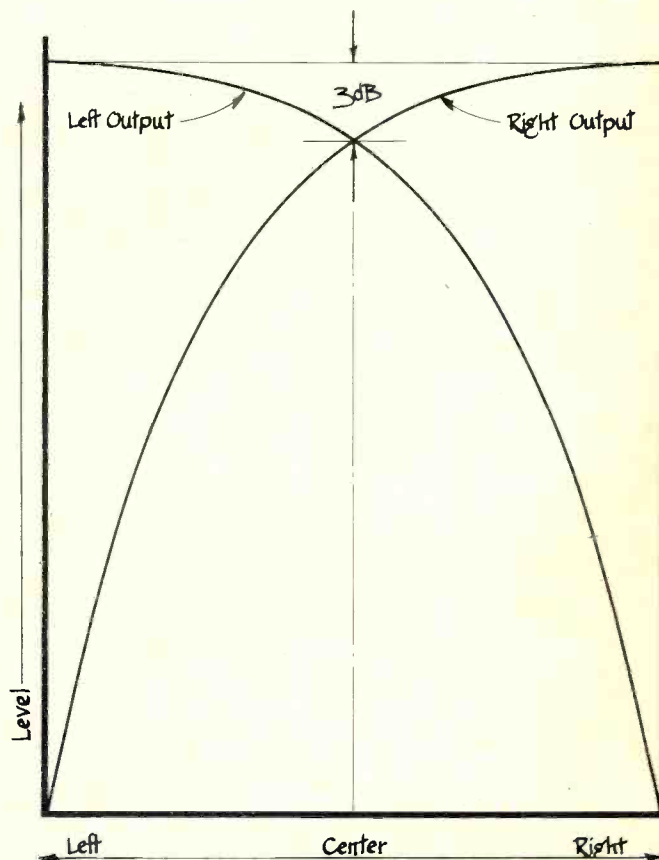


Figure 1 LEFT AND RIGHT OUTPUT LEVELS VS PAN-POT ROTATION



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An important requirement for a pan pot network is to maintain a constant total sound power level as the signal is panned from one side, through the middle, to the other side. To accomplish this the output level from both channels with the pan pot centered must be 3dB below the output level of one of the channels with the pan pot turned fully to that side, as shown in the graph of Figure 1.

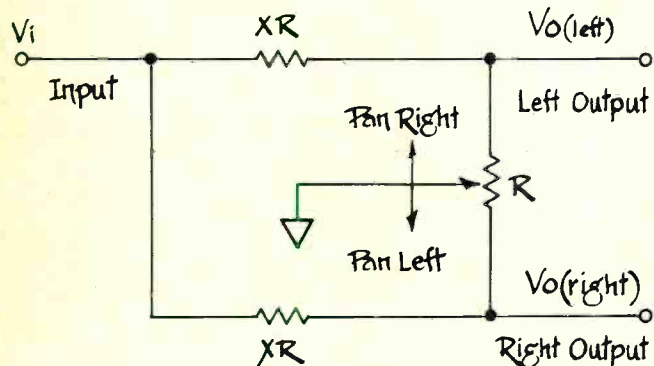


Figure 2 A SIMPLE PANNING NETWORK

Figure 2 shows a simple panning network that is built with a single linear potentiometer. Choosing the right proportionality factor "X" will assure a constant total sound level while panning.

"X" can be determined in the following manner: When the potentiometer wiper is centered,

$$V_o(\text{left}) = V_o(\text{right}) = V_i \frac{R/2}{XR + R/2}$$

and when the wiper is at one end of R, say in the full LEFT position (which grounds the RIGHT output),

$$V_o(\text{right}) = 0 \text{ and } V_o(\text{left}) = V_i \frac{R}{XR + R}$$

Now 3dB below the maximum output from one side is equivalent to about 70% of the output from that side, so we can say,

$$\frac{V_o(\text{left}) \text{ Wiper at MID position}}{V_o(\text{left}) \text{ Wiper at LEFT position}} = 0.70 = \frac{\frac{R/2}{XR + R/2}}{\frac{R}{XR + R}}$$

Solving for "X" we have X = .75

A little more algebra will show us that $V_{out}(MAX)$ from either output is about 57% of V_i , which indicates an overall insertion loss of about 5dB.

The resistances are fairly critical and 1% tolerance components should be used, keeping in mind that the fixed resistor values are proportional to the absolute total resistance of the pot. The degree of matching of fixed resistors determines the precision of the pan pot center position, and the proportionality factor "X" affects the overall insertion loss. The potentiometer must be chosen for minimum and resistance (resistance to wiper at either end of rotation) to minimize leakage when panned fully to one side.

All of this discussion presumes that the outputs are not loaded, and in fact any significant loading will change the balance of the network. In practice satisfactory results are obtained if the outputs are loaded with no less than 10R, which increases the insertion loss only about 1/2dB, and has even

less effect on the -3dB points.

The input impedance of the network varies slightly depending on the position of the panning wiper, from a minimum of .625R with the wiper at one side to .636R with the wiper at mid-position.

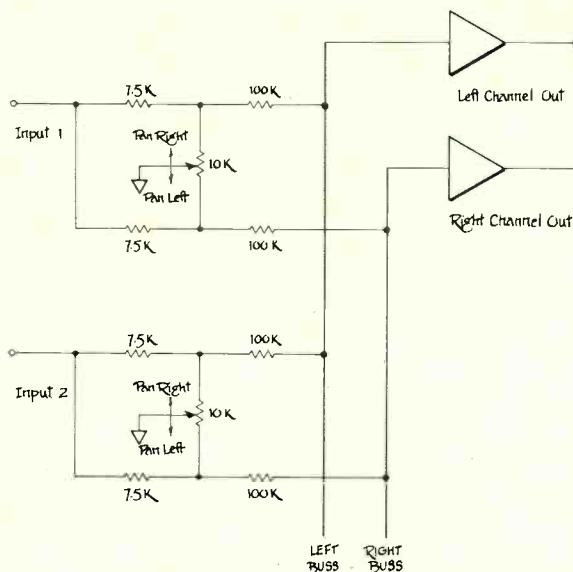


Figure 3 MULTI-CHANNEL PANNING INTO STEREO BUSES

The outputs may be directly summed into main left and right output buses which may carry inputs from other panning networks, as in Figure 3. The summing amplifiers for the left and right buses may be strapped for gain to make up for the insertion loss of the panning network. The resistance values shown are typical practical values.

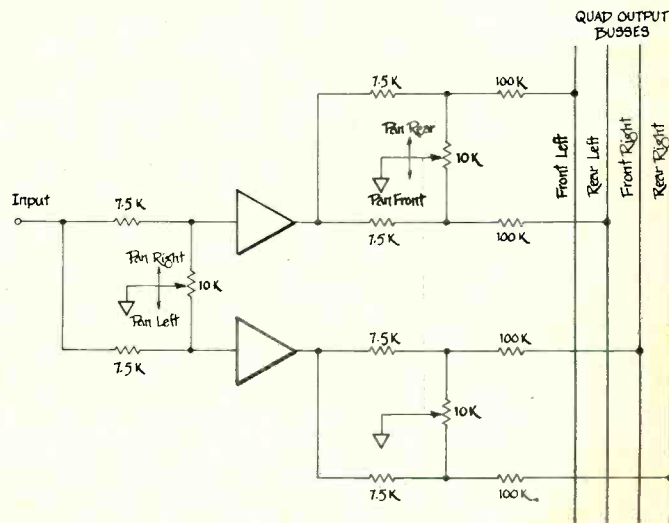


Figure 4 FOUR CHANNEL PANNING NETWORK

This basic panning scheme can be carried one more step to provide a 2 knob, 4 channel panning network, as in Figure 4. In this case the single pot is used to pan from left to right buses, and these buses supply a dual panning network for front to back panning. A buffer amplifier should be inserted between the single and dual pot networks to keep the impedances down and to minimize insertion loss.

The buffer and combining amplifier circuits are up to you, the designer. The important thing is to keep the gain vs level vs impedance relationships of the panning network optimized for the associated buffer and combining amplifiers.

Dear Audio World,

In order to clarify certain rumors regarding our work in the area of digital control of audio consoles, we do hereby submit this

WIZARD OF MIXDOWN

Yes, we are working on a brand new Automated Mixdown System! Why, you ask? Isn't Allison Research already established as the industry leader? Well, frankly, yes. And we intend to stay that way!

Think of it this way. Imagine you were in the garbage business! Say you could put 250 cans of stuff on your truck and take it to the city dump in 3 hours.

One night as you lay in the sack you get this nifty idea on how you could take 8000 cans of garbage to the dump in 10 minutes! Now really, what would you do? Even though you were the only game in town would you wait for some other joker to get your idea?

That's the kind of dilemma we had when we discovered how to put over 60,000 bits of ultra-reliable mixing information on one track of audio tape!

Imagine how we felt when we saw that we could program every control on a 32 track console and still have enough code left to do 15 or 20 more consoles like it! The clincher came when we figured out how to move any one of the controls and get back the information inside of 1/200th of a second!

You should have seen us torture the poor prototype. We mixed the code with white noise (10dB down) and turned the reels of our Revox by hand. (Look Ma, no capstan). From out of the wow and gurgle, out comes the data, just like we put it in! We even took an electric drill to it while it was decoding, but couldn't fool it!

Right now we're putting the thing in a tidy little box so it will look nice in your studio, come this fall.

In the meantime, we're conjuring up all sorts of goodies to go with it, like programmable super equalizers, panners, limiters, expanders and even patching systems. We're also prescribing a firm code of standardization so everybody's systems are nice and compatible.

Speaking of everybody, we're sure glad that some of the world's greatest console builders are working with us to make this project truly great!

Sincerely,

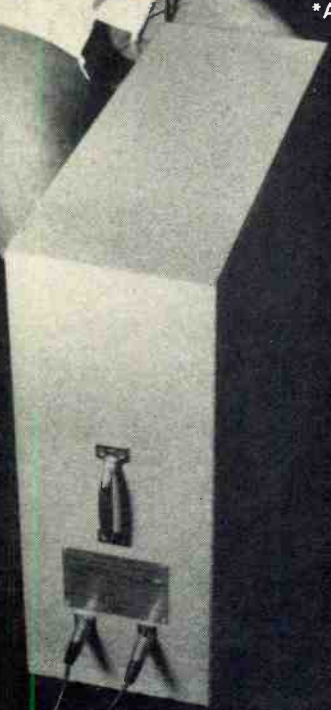
Allison



Don Sciarrotta, Rufus engineer, "tells you something good" about the Cooper Time Cube.

"I think the Cooper delay is something good. It has more of a room sound and it makes the room sound bigger. The electronic delays have an 'electronic' sound. The Cooper's versatile, too. I can use it with a tape machine by itself, or I can put one before it and after it, or I can patch it through my echo chamber. When we recorded the 'Rags to Rufus' album*, we used just the Cooper with the voice bag and the voice at the same time. The double delayed Cooper was used on the voice for the verses and choruses, the bag was Coopered only on the choruses. The result was a great doubled voice sound. The album was gold and also had two gold singles. One was 'Tell Me Something Good'. That's why I like the Cooper Time Cube. With it we got just the sound we wanted. I've had my Cooper for two and a half years without any trouble at all . . . I've replaced one light bulb."

*ABC Records, Bob Monaco Producer



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The controversial emergence of the Doors on the pop scene in early 1967 heralded the beginning of a new musical era. Of all the groups that had come and gone in rock music's second generation, possibly none represented a greater leap forward in musical sophistication or the live performance than the Doors.

Not only the first major "progressive" group, the Doors were perhaps the first real "expertise" band as well. All three musicians were highly regarded, to the point of their musicianship being acknowledged even amidst the ranks of more traditional players. Noteworthy was the fact that they featured Ray Manzarek's classically-oriented keyboards as the leading musical voice, where till then almost every other group had used guitar. Also an innovator, Robby Krieger was maybe the first major guitarist whose style was not based around the six-tone "minor blues" scale. Likewise, John Densmore's fluid jazz drumming was a radical departure from the standard backbeat percussion of the time.

a production analysis of the **doors** **STRANGE DAYS**

an in-depth interview with:

producer **PAUL ROTHCHILD**
engineer **BRUCE BOTNICK**
guitarist/composer **ROBBY KRIEGER**

by
PAUL LAURENCE



As might be expected, the Doors' music was a far cry from the rock & roll- and R&B-derived styles of that time as well. Theirs was a striking fusion of classical, blues, jazz, rock, theater, and flamenco, circumscribed by a truly unique and instantly-recognizable sense of chording and melody. Their trademarks were deft little excursions away from the main theme, super-tight syncopations (often involving a tradeoff between instruments), and general musical "wittiness." At improvisation they were equally facile, fashioning some of the boldest and most stylized extended forms ever done.

Lyricaly, the Doors broke new ground as well, exploring subjects heretofore ignored in popular song in creating a body of work over-run with apocalyptic visions, Oedipal dramas, anarchy, reptiles, and sadism. In leather-clad vocalist/composer Jim Morrison, the Doors had the first American rock superstar. The self-proclaimed "Lizard King," his surreal images and novel posturings had many convinced that it was indeed the Doors (and not the Rolling Stones) who were most responsible for the sorry state of the world at that time.

The Doors' recorded sound is clean and concise. As they were pretty meticulously close-miked with a fairly high percentage of the tracks having been overdubbed, their records have little leakage, live ambience, or extraneous sounds. This state was pretty much preserved in the mix, as they used little reverb and only an occasional tape delay. This clarity of sound, in conjunction with the Doors' highly visual textures, makes their records truly "aural paint-

ings" rather than "musical performances."

The vocals are very clean and up-front. They often used only one voice per song, and as it was plainly audible, it was clearly intended to be the song's focal point and not just "another track." Occasionally a delay was run off the lead vocal, usually low-level and unobtrusive for "ambience."

The wide variety of keyboard instruments were close-miked when miked, often taken direct, and usually mixed as mono tracks. Occasionally, the keyboards were run through a distortion unit (most often tremelo and fuzz) to create some striking and unique textures.

The guitars were usually played at a moderate distortion level, ultimately having a wide variety of tones. Like the keyboards, they were often modified with tremelo and fuzz.

The bass guitars (as played by Larry Knechtel, Robby Krieger, Doug Lubahn, Kerry Magness, Harvey Brooks, Ray Neopolitan, Lonnie Mack, and Jerry Scheff) were usually played at a moderate distortion level and have a clean and fairly rich sound. Occasionally, the bass will be a song's most up-front track.

The drums, like those of most of the jazz-inclined rock drummers, have a crisp, high end-y sound with not much kick drum. When stereo, there is little perceivable movement within the kit, a joint result of overhead miking and a conservative spread. Occasionally, a delay was run off the snare for "ambience."

Producer Paul Rothchild started his illustrious career 13 years ago in a library in Boston.

Since then, he has gone on to become one of the most successful and widely respected music industry figures of either Coast. He has produced over 100 albums (10 of them gold) with artists like Fred Neil, Tim Buckley, The Paul Butterfield Blues Band, Joni Mitchell, John Sebastian, and Janis Joplin. Between 1963 and 1968, he served as director of recording at Elektra Records. He is currently producing Bonnie Raitt for Warner Bros. and the Outlaws for Arista.

Engineer Bruce Botnick is likewise one of the recording industry's most celebrated figures. In his 14 years on the professional recording scene, he has amassed nearly 30 gold LPs in recording artists like the Beach Boys, Jackie DeShannon, Herb Alpert & the Tijuana Brass, Marvin Gaye, the Supremes, Buffalo Springfield, Mack Davis, and Helen Reddy. From 1963-1969, he worked at Sunset Sound, becoming its head engineer and later studio manager. Current projects include producing guitarist Dave Mason and jazz drummer Tony Williams.

"Strange Days," the Doors' second LP, is a landmark effort in the evolution of modern studio technique. As what many consider the American counterpart to the Beatles' "Sergeant Pepper," it was one of the very first records to feature the Moog Synthesizer, multi-speed recording, backward tracks, and such a wide spectrum of tones. Released in October of 1967, "Strange Days" had a run of 63 weeks on "Billboard"'s album chart, during which it reached the Number 3 position.

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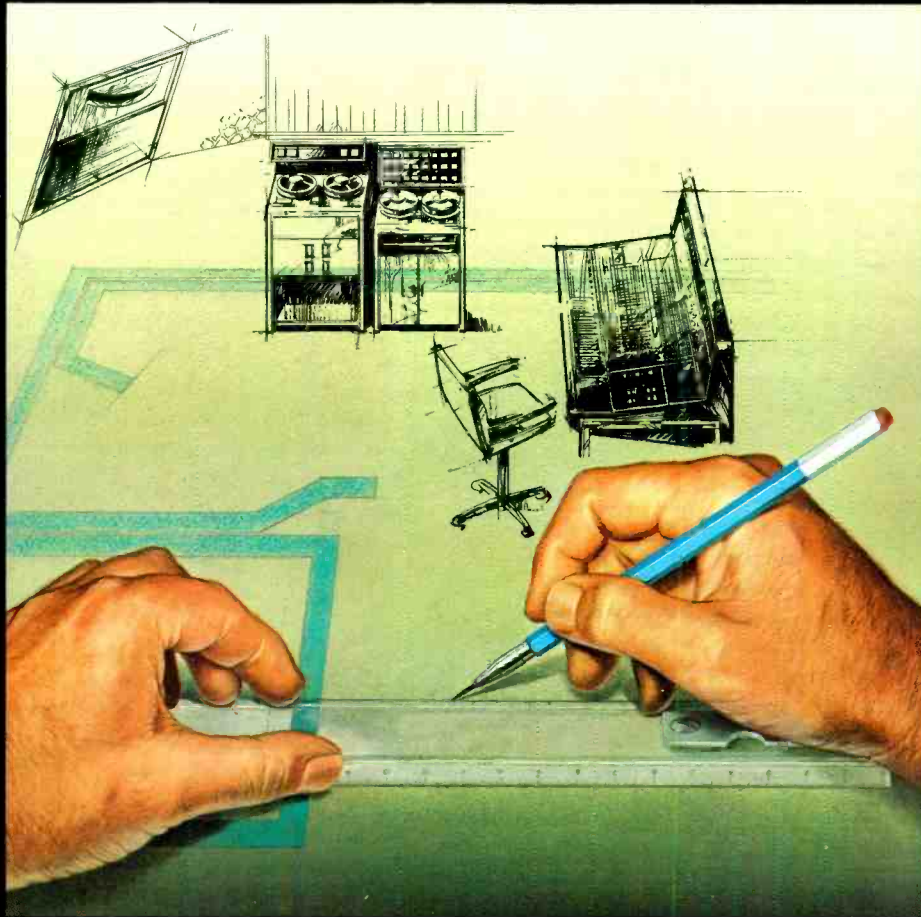
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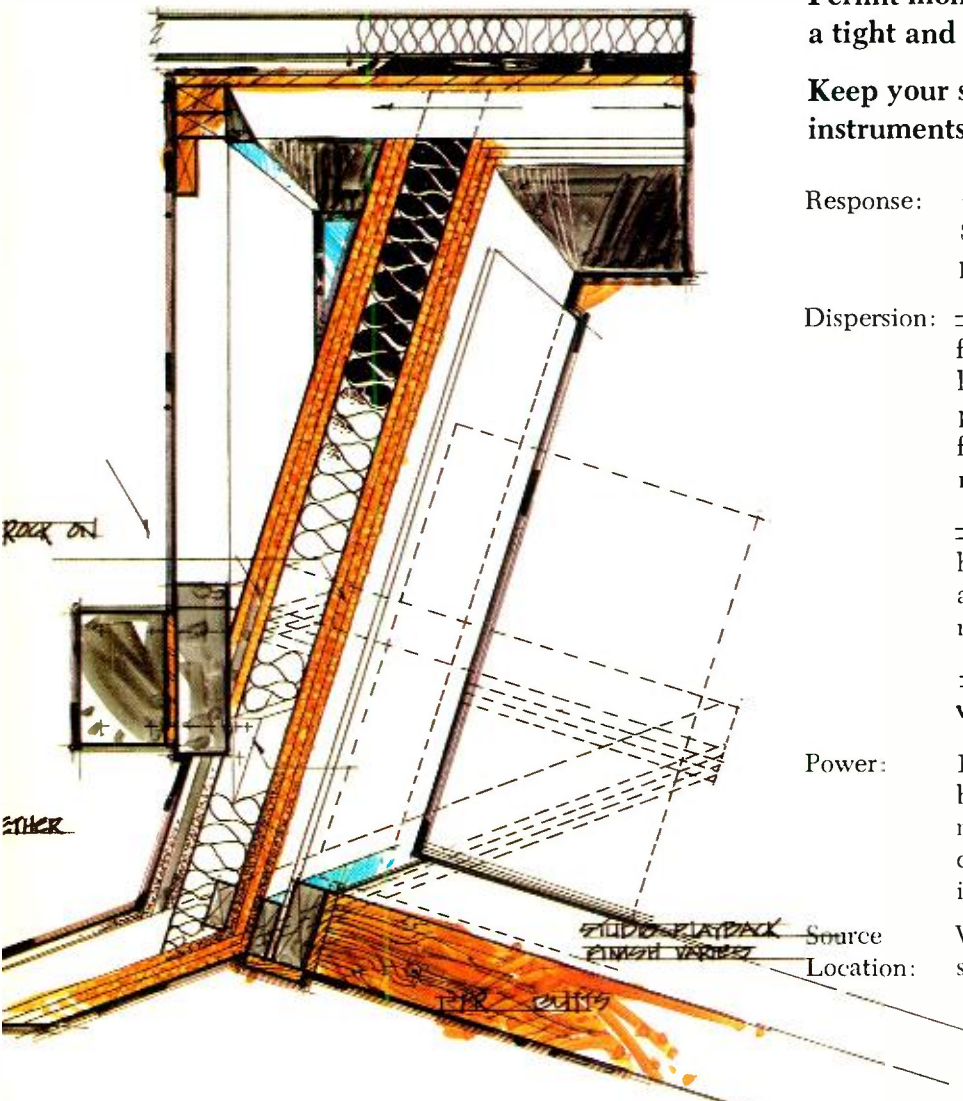
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Audio**

"The control room sounds good here but not over there. Stand up and you've lost your mix. Lean back in your chair and all the bass is gone. The monitor has to be loud to hear it. Turn your head and big changes occur. The stereo image moves."

"The drum leakage in this studio is terrible. The strings sound great but the bass is loose and muddy. This room is so dead the sound isn't happening and the musicians can't get into it."

These are subjective observations which producers and engineers have made and lived with for years in many studios. We at Westlake are prepared to talk to you about a guarantee *against* those things happening in your studio.



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WE WILL GUARANTEE YOU A CONTROL ROOM WHICH WILL:

Allow you to stand . . . sit . . . lean forward or back . . . move left or right and subjectively not change your mix.

Let you accurately pinpoint any musical instrument within a 360° quad listening environment.

Permit monitoring loud or soft while retaining a tight and musical sound.

Keep your stereo "locked center" on all instruments panned to the middle.

Response: ± 3 dB upon speaker installation, 31 Hz-16 KHz measured with B & K $\frac{1}{3}$ octave pink noise source. *Between speakers*, ± 1 dB.

Dispersion: ± 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.

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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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*Available on all new projects from Jan. 1975 on.

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Have a tight rhythm sound under all recording conditions yet allow the producer and engineer the option of changing the midrange character anywhere from “dead” to “very live” in less than sixty seconds. — *Any location in the room.* —

Provide drum cages which are live inside, something that the drummer can get into, allowing you to get a bright drum sound from an open drum cage.

Let you obtain a natural piano sound with excellent isolation from loud electronic instruments. — *With the piano in the room, lid open and not caged in.* —

Provide an echo chamber with low end “mud” removed by trapping in the chamber, resulting in a chamber that “sings.”

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 *at* 40 Hz or tuned frequencies.

Traps: Drum cages, bass traps and broad band attenuators will provide in excess of 24 dB isolation *at* 40 Hz. The piano can be recorded in the studio while still providing over 20 dB broadband rejection of unwanted sound to the piano mikes *with lid open!*

THE CONTROL ROOM AND THE STUDIO ARE YOUR TOOLS AND SHOULD WORK FOR YOU... NOT AGAINST YOU.

THAT'S WHAT AN ACOUSTICAL GUARANTEE IS ALL ABOUT!



DOOR JAMB DETAIL

Kent R. Duncan, President, Kendun Recorders, Burbank, California:

"The new room has been in operation for six months now and our success is as much a tribute to Westlake Audio and Tom Hidley as it is to our long hours and attention to detail (and possibly some good engineering). Our Westlake room made us a 2 studio operation but instead of just doubling our gross, we went from \$12,000 a month to \$60,000 a month. The incredibly accurate planning of our Westlake turnkey installation resulted in completion exactly on time, response precisely as promised, all equipment functioning within one day of installation, and all within budget! In the past six months we have mastered such acts as Stevie Wonder, Bob Dylan, America, Buddy Miles, Fleetwood Mac, Rick Nelson, Tower of Power, Livingston Taylor, Isley Bros., Rod McKuen, Nitty Gritty Dirt Band, Emitt Rhodes, Richard Greene, El Chicano, Nana Mouskouri, Cleo Laine, Bola Sete, San Sebastian Strings, Jo Stafford, Maxayn, Pharoah Sanders, Archie Shepp, Ballin' Jack, Vickie Lawrence, Maureen McCormick & Chris Knight, Don McLean, Vikki Carr, Bill Medley and even Rodney Allen Rippy. Over half these acts were recorded on Westlake monitors in various studios around the country, attesting to the fact that truly, you are the professional."

Christopher Stone, President, Record Plant Recording Studios,

Los Angeles: *"As you know, we have used Westlake Audio and yourself since the inception of the company for all of our studio design, construction, electrical interface and implementation. During the past four years you have designed and implemented eight studios for us in New York City, Los Angeles and Sausalito. Obviously we are known as a Westlake-designed operation. We have built our total reputation around your studio design and have always been happy with our decision to utilize you on an exclusive basis for all our acoustical requirements and equipment consultation. The success of your design speaks for itself in the form of our success as an independent studio operation."*

John Sandlin, Vice President A & R, Capricorn Records, Macon,

Georgia: *"Words alone cannot express my appreciation for the friendly and courteous atmosphere I enjoyed while at Westlake mixing Bonnie's (Bonnie Bramlett) album.*

It was really a pleasure to work with such extremely competent and dedicated people. Thank you for giving me an opportunity to experience the automated mixing facilities and to work around the type of people I love and can relate to.

Take care of Baker, he's incredible."

John Boylan, John Boylan, Inc., Hollywood, California:

"First of all, this is my third project in a row to be mixed on your monitors and once again it looks like we have a winner — a record that sounds as good at home as it did in the control room. From a producer's nontechnical viewpoint, this ability to trust a studio monitor and come out with even results is extremely satisfying. Secondly, the Westlake Monitor never seems to vary in any substantial way from studio to studio, in the control rooms that you've designed. So I have no worries about consistency in today's widely dispersed recording scene."

WE PUT OUR MONEY WHERE OUR MOUTH IS!


Below are excerpts from a typical acoustical system acceptance from a client authorizing the release of the final portion of the construction monies from a trust account.

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.

SOUNDS INTERCHANGE LTD.

By 
Dated DEC 6/74

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maximizes the second harmonics initially, then you've got musical leakage. If you equalize that, you can only make the sound better. This is what differentiates a "good" from a "bad" room – its standing wave action and how that influences the harmonics.

The basis of what was happening over at Sunset Sound was that Bruce was very familiar with the room and was therefore really able to utilize its live aspects. A room like the old Studio 1 had a terrific overtone situation. That's why drums always sounded so fantastic there. Rather than go for that baffled sound, we actually used the leakage in the room. There's a lot of leakage on the first Doors' album, but it's good leakage. It's the kind you go for – the kind that gives you a live feel.

PL: Through the course of the Doors' albums, was there any particular way or time of recording that you evolved into? Did you use to record during the day, at night, with just the rhythm section, live vocals – what?

RK: We'd usually come in around 2:00 and work till we burned out. The vocals were almost always live because we couldn't have gotten the feeling down on the tracks without them.

PR: For the first album, Jim was in the booth entirely except for parts of "The End." He would be in the booth, and then he'd come out to the studio, and then he'd run back into the booth. That was because it was generally better for him to be in the studio with the band, but there were some situations where he couldn't because the band would be too loud, and so he'd run to another mike in the vocal booth. I remember that vividly.

PL: How many takes did "The End" take to record?

PR: Two takes. That entire first album was recorded very quickly – nine days, I think it was. "Light My Fire" was just two takes also. The only real overdubs on that record were some vocal doubling and the bass. There were also some incidental percussion effects, like on "Twentieth Century Fox." That's all the Doors standing up, stamping on a wooden drum platform.

PL: Didn't you occasionally have a keyboard bass and a bass guitar going at the same time?

PR: Yes. The bass was there primarily to reinforce the part that Ray was playing on piano

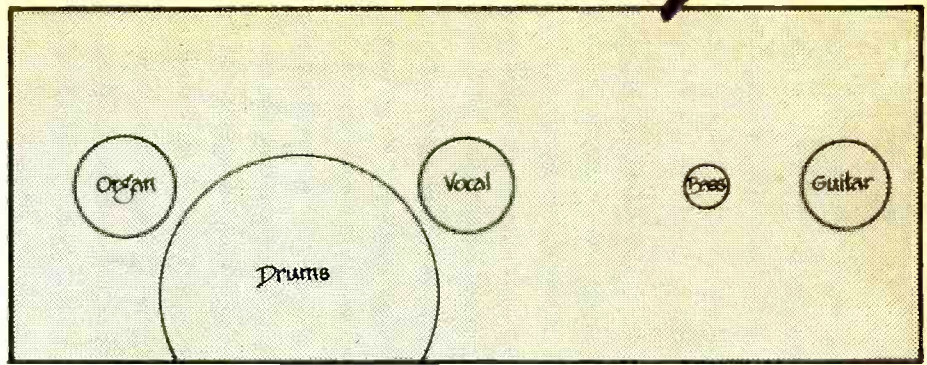


Figure 2 COMPOSITE VISUAL SCHEMA OF "HELLO, I Love You"

bass. We used a bass on two or three cuts – "Twentieth," "Light My Fire," "Take It As It Comes" . . .

RK: And "Back Door Man." I remember because I played the bass on that one. The other three were Larry Knechtel.

PL: What did you look for in a bass player?

PR: Strong people that hung out real good. They were all bass players who were sensitive to what the Doors were trying to do. Of all of them, I think perhaps Doug Lubahn did it best. He really understood the Doors' concept.

PL: Did you originally have "Light My Fire" lined up as the album's second single?

PR: Not at all. Nobody really thought it was a hit record, including everybody at Elektra. It was outside the rules sufficiently to where we hadn't considered it as any kind of single. We had originally released "Break on Through," which got a lot of airplay but didn't sell that many records. Meanwhile, it reaches a point where the radio stations are getting overwhelming requests for "Light My Fire," and so we edited it down and released it as a single.

PL: Which album would you like to play for the "blindfold test"?

PR: Well, as far as studio technique is concerned, we probably used more of it on "Strange Days" than on any other.

PL: Would you say that it was one of the earliest "hot studio effects" records?

RK: Definitely. "Sergeant Pepper" hadn't even come out yet. Actually, I think it came out while we were in the middle of recording "Strange Days."

PL: What were the circumstances surrounding the recording of "Strange Days"?

PR: Well, the first album was the Doors as almost an Electronic Art Group – a live documentary recording of them as they appeared on the doorstep of Elektra Records, sharpened up for the record-buying audience. That's essentially what they did live, with very few studio things done at all.

On the success of their first album and "Light My Fire," the Doors had a real platform to spring from to bring all of their musical ideas to the American people. "Strange Days" was that next step. It was essentially the Doors' first studio album, not only because we had eight tracks of tape, but also because they weren't as familiar with the material. We could do less simultaneously, because it was not a worked-out club set like before. With the second album, the Doors' sound takes on a greater maturity all at once because of studio technique. We were trying to be avant-garde, and in so doing, we sacrificed some of the freshness and spontaneity for the drama and staging that you can get in a "produced" album.

BB: "Strange Days" was recorded in a two-month period starting around May of 1967. It was done in segments – we'd do two songs and then shut down while the Doors went on tour, then we'd do another five tracks and they'd go on tour again. That sort of thing.

PL: When it came out, I remember thinking that it was the strangest record I'd ever heard. Was that on purpose?

RK: No. I wouldn't say that. It was pretty much just where our material was at at the time.

(at this point, the "blindfold test" was initiated and "Strange Days" was put on)

STRANGE DAYS

PL: What are you doing to this delay here?

PR: That's a Moog. This was one of the earliest uses of the Moog Synthesizer. Bruce and I had both heard about Moog and decided it would be ideal for a weird effect.

BB: Yeah. Jim's voice is going through a Moog and being actuated by a key on the keyboard

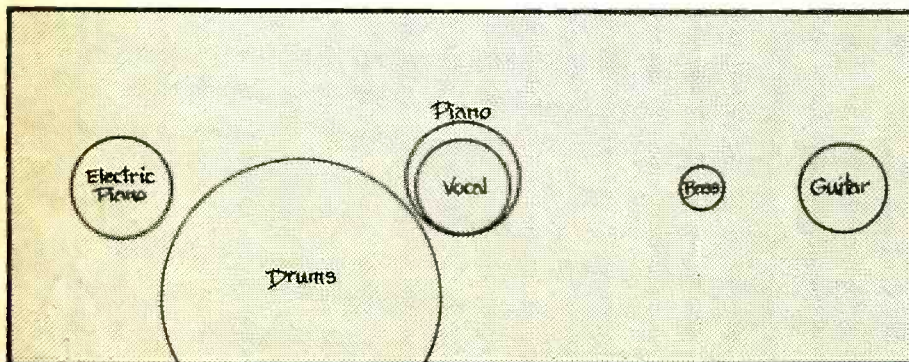


Figure 3 COMPOSITE VISUAL SCHEMA OF "LOVE STREET"

during the mix. Jim pressed the key, because he knew his phrasing better than anyone else.

This thing has three organs — one recorded at normal speed, one at double speed, and one at double slow speed. This was our first attempt at recording multi-speed sounds.

RK: This also has a guitar that was recorded at half speed.

YOU'RE LOST, LITTLE GIRL

PL: Is there any effect on that guitar?

RK: It's two guitars playing the same thing.

PL: What kind of vocalist was Jim to Mike? Was there anything in particular you had to watch out for?

BB: He was easy. I'll tell you, Jim was one of the few vocalists I've ever recorded that really knew Mike technique.

PR: Yeah, he had great dynamic control. He also knew how to stay put — to keep his distance right and not drift.

BB: As a rule, most vocalists don't study vocalists. Jim was a great student of other vocalists. Frank Sinatra was one of the big ones for him. You know, he would really listen to the sound of their voices. When he would hear himself on tape, he would realize that if he wasn't hearing what he wanted, it was him. Through experimentation with whatever it was he was singing and the distance from the microphone, he could achieve just the effect he wanted.

PL: I've always said that Jim Morrison could have been a hit singer anytime in the last 30 years.

PR: He was the great crooner of our time. He's right in there with Bing Crosby, Vic Damone, Elvis — all of them. He has that same natural, creamy style.

LOVE ME TWO TIMES

BB: On this song, Ray was playing two pianos at one time. The right hand was a tack piano and the left hand was a grand. Then we dubbed a harpsichord on top of it.

PL: I can hear a real continuity in sound between the early Doors mono drums and the later stereo ones.

PR: Mono is still the strongest idiom for reproduction of sound. You don't have those phasing problems because your perspective is looked in. When you go into people's homes, in 80% of the places where you'll see stereos set up, you'll see one loudspeaker up on a bookshelf and another one down on the floor, or a loudspeaker in the living room and the other one in the kitchen! With mono, that doesn't really matter.

BB: In mono, you can take instruments and put them further behind one another — you can build "layers" — where in stereo, you're spreading things out and it's a little bit more difficult to create perspectives of depth and distance. With stereo you're "pinpointing" your tracks, versus mono or binaural, where the instruments fall into a more natural positioning.

PR: You can get much better "three-dimensionality" in mono, strangely enough. Although it seems like it should be the other way around,

you get the feeling of space much better in mono than in stereo.

UNHAPPY GIRL

PL: What kind of backward track is this in the middle?

BB: I think it's an organ.

PL: Paul, you mentioned that the Doors were playing some of these tunes when you first saw them. Did you purposely hold them back for the second album, or was it a case of not being able to get them down on tape to everyone's satisfaction?

PR: Both. The first album was made to be the best first album, and any tunes that were left over were painfully eliminated from it. This was because some needed to be re-worked before they could be recorded, and others because they didn't fit conceptually with the other songs. "Summer's Almost Gone" didn't make it till the third album, even though they were performing it at the Whisky when I first saw them. The Doors and Bruce and I have always thought that an album should be an entity — a feature-length movie rather than a shorts festival. A lot of artists make the mistake of putting out albums that don't have continuity, that are just a string of different-colored beads. We're very much into an album having an entertainment goal — that it take you to a very specific place.

HORSE LATITUDES

PL: I always felt that this was one of those songs that was pretty much created in the studio.

RK: It pretty much was, except for the words. We did a lot of "inside-the-piano" fooling around with the strings. Lot of screaming.

BB: On those piano tracks, we did lots of infinite tape repeats recorded live so that our perspectives held. For the wind noises, I fed an amplifier from the board into the echo chamber, and it just went "haaaaaaaaaaaaaaa."

PR: Yeah. We de-tuned a tape recorder — changed the bias and the noise balance — and pushed the "record" button. Then, while the machine was still in "record," we went outside the capstan and hand-turned it at different speeds, creating a variation in the bias current. It was "hand VSOing"! I think there are three channels of that.

MOONLIGHT DRIVE

PL: Do you have a distant Mike on this bottle-

neck guitar here?

BB: No. It's just the famous Sunset Sound echo chamber and some delay using a special tape machine. It had a special equalization that enhanced the rising time of the chamber.

PR: That machine was a very unique machine. It was Ampex serial number 0003 — the third Ampex ever made — upgraded to half-inch, 3-channel capabilities. It's probably the only one that has ever existed.

PL: What are you doing to this solo?

BB: Straight old guitar with some echo and some fuzz.

PL: Robby, I always thought this was one of your best solos.

RK: Yeah, somebody else said that to me recently too. You know, I've liked almost all my solos or I wouldn't have let them go on the tape, but I was never that crazy about this one myself.

PL: Did you generally have a pretty good idea of what kind of solo you wanted to play?

RK: It depended. On a song that I'd played in person a lot, the solo would be pretty far along. If it was a new song, I'd experiment around.

PEOPLE ARE STRANGE

PL: I noticed that on this album, you tried to preserve a continuity in panning positions, paralleling the way they set up on stage.

PR: Yes, I do that to this day. I think it helps the listener to be able to "fix" the band in his mind, rather than "destroying the set" every three-and-a-half minutes. I find that very disconcerting. I guess it really depends on what kind of albums you're trying to make. It's perfectly valid on some albums, but I don't tend to make those kinds of records. I like the musical concepts involved to be portrayed by the people involved, and so it's important to me that the set stay up, so that the listener can "make friends" with the different personalities. If I look to the middle, I can find the drummer and the singer and probably the bass player. If I want to hear the guitar, I'm going to be able to look in this direction, if I want to hear the keyboard, I'm going to look in that direction, etc. Another example of a vogueish studio trick would be panning a keyboard from left to right. To me, that's like cartoons. In my mind, I see a whole bunch of sweating guys moving a piano across the room, which is great if you're looking for a funny effect. To me, that sort of studio effect is totally outside the reality of a

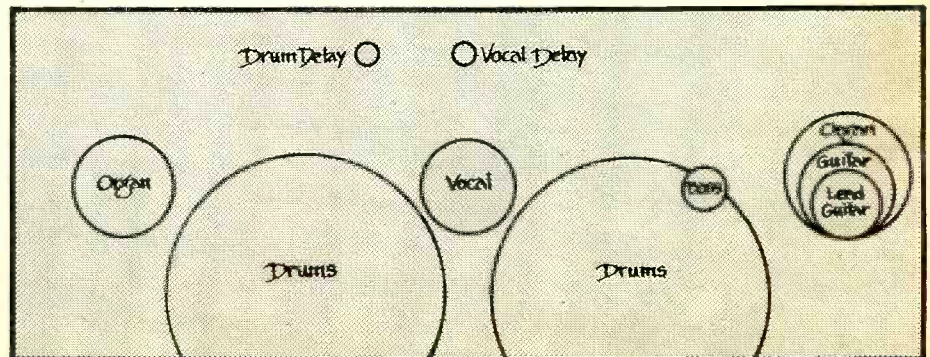


Figure 4 COMPOSITE VISUAL SCHEMA OF "NOT TO TOUCH THE EARTH"

musical situation.

All musicians and producers are in a dangerous situation once they forget that their main goal is to translate music to the listener. You see, the studio itself is abstracted from the real world, and it's very easy to make esoteric games there to entertain yourself and a handful of other cognoscenti. When you've done this, you're not getting your music to the people who need to hear it. In a phrase, you can out-hip yourself by making records exclusively for yourself. It's what almost became the death of jazz, for instance. It became so introspective and incestuous as an idiom that it wound up entertaining only itself and it excluded the audience. The minute that jazz started including the audience again, it started to live.

MY EYES HAVE SEEN YOU

PR: This is a great arrangement — a classic arrangement. This was the first tune that we recorded for this album, and I thought it was the most impressive piece of rock & roll I'd ever heard. I thought it was a smash single, but Holzman said no.

PL: What were his criticisms?

PR: He had no criticisms of it, he just said "Let's wait until the album is finished and pick out something else."

PL: Did every record go through him before being released?

PR: Pretty much. You know, you can't release a record without the approval of the record company. Some groups get record companies to release a record, but if the company doesn't believe in it, they won't promote it, so you

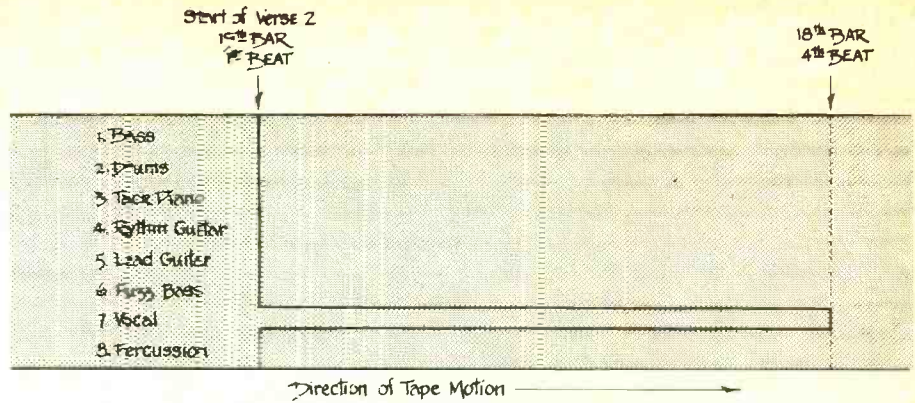


Figure 5 DIAGRAM OF WINDOW EDIT OF MASTER TAPE FOR "MY EYES HAVE SEEN YOU"

really do need that backing.

The whole front half of this song was one take and the whole back half was another. That cut entailed a long window edit of the master tape. At that very point, we wanted the vocal to overlap the guitar, and, using a tape reader so we could visually see the tracks, we had that track extend a few inches beyond the others.

PL: What exactly is a tape reader?

BB: A tape reader is a unit that's put out by 3M. You put this circular on the tape, and using a thing that looks like a magnifying glass, you can actually see the tracks — see the magnetized particles.

PL: Did you often edit the multitrack master?

BB: Oh yes. When you're cutting your mixed master, there are all sorts of problems that can

come up. Your levels change, and sometimes you can't even make the cut because it would be an obvious edit. I always cut the master tape — even 24-track. If you know how to edit, you're not going to make mistakes. That continuity is important, especially if you're overdubbing. With the Doors, we often overdubbed a bass and so it was imperative that the tracks already be locked together.

PR: Fight. If your segments of tape aren't connected before you overdub, then you have to overdub that part on two different segments — the one that you're going to use for the front and the one that you're going to use for the back. After you've made the splice, your overdubs are going to help it cohere because there will be notes that fall so close to the cut that eventually everybody will nullify it.

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I CAN'T SEE YOUR FACE IN MY MIND

BB: That's Ray on marimba with a little tape repeat. The backward track is a high hat. I should tell you that as we were making these records, a lot of what happened happened by itself. We were in a flow and we went with it. We didn't try to guess where we were going — we just followed it as it happened. If an idea came up, we just tried to expand it to its limit.

PR: Yeah, a lot of these techniques were purely serendipitous. It was often just discovery by happy accident more than anything else.

WHEN THE MUSIC'S OVER

PL: How did you get this freakout guitar sound?

BB: That was created by overloading two amps in the board in conjunction with a diode.

PR: Right. That particular "fuzztone" was just a little diode we dug out of a box. We thought "Why don't we take the smallest part we can and drive as much signal as we can through it?" We just inserted it in the buss, alligator clipped it to a patch cord and drove the signal through it till it went nuts. I've used that diode as a fuzztone many times in the past when none were available.

PL: Was this about the way you used to perform this song?

RK: This is a much shorter version, really. It was much longer live, and so it came out different each time. This is more or less just a skeleton of what the song was in person.

PR: By the way, this is a hand-held mike right here. Jim frequently hand-held a mike in the studio so he had the freedom to move. For instance, when he screamed "Now!" he was off the ground. Literally jumping.

PL: You get such a nice clean bass sound. Was it usually taken direct?

BB: The bass was usually miked, actually. The big thing that we tried to do was get the sound in the room. A good sound is 80% in that room.

PR: There's something that a lot of people don't understand today. I usually say "Most of a recorded sound happens at source." I'm talking about the instrument itself. You can take a bad acoustic guitar and add all the miking technique, all the limiting, and all the EQ you want to it, and what you'll come up with is a bad guitar that's been screwed around with. It's really important to get a great recorded sound. You can't win until you've got a great sound at source. Robby would pay lots of attention to the sound of his instrument. Guitar players in particular are maniacs about customizing their instrument to get it to sound right. We were into getting amplifiers to be right, positioning them in the room so that the ambient sound was correct — all of that. We would set things up so that when there was leakage, it was good leakage. Bruce has the advantage of having been engineering across a transitional era — the transition between live recording and multitrack recording. The engineers that learned early technique had to work with leakage. Only just recently is leakage coming back as a means of getting a sound. Like all those Southern guitar bands — they have a very live kind of sound and people are responding tremendously to that sound today. It's really just re-learning how to use leakage in a

recording situation.

BB: Like Robby, John was heavily into — all of them were — the sound they got in the room. They would always come in and say "Hey, It doesn't sound like what I've got out there." Then we would spend the time to get it to sound like that, because we felt it was important to represent on record who they were and what they were.

PL: You did occasionally take two tracks of bass, didn't you?

BB: Sure, but only towards the end when we had 16-track and could afford it. Before that, we were usually forced to make our decision before we recorded.

PL: Did you have any general equalizations?

BB: What we tried to do was bring to the public on phonograph record exactly what the band was saying without getting in the way of their music. If it took 5dB of equalization at 10 Kc to do it, we did it. There was no standard EQ, though. You cannot do that.



"You have to apply the first rule of the recording studio, which is
WHATEVER WORKS."

PR: You have to apply the first rule of the recording studio, which is "Whatever Works." Each studio is different, each drummer is different, each drum set is different from day-to-day!

BB: Right. Sounds change with heat and humidity even, and when they do, you just have to roll with them.

PL: What track tape did you use for the Doors' albums?

PR: Well, the first album was recorded 4-track, and of those four, only three were really used. There was a vocal track, and then there was a stereo left and stereo right, where the band was located in a stereo mix.

BB: Which was bass and drums on one channel and guitar and organ on the other.

PR: Which was supreme naivete. The second and third albums were 8-track, and the fourth and fifth were 16-.

BB: The live album was recorded 8-track. I used multiple miking for the band in conjunction with a Neumann SM-69 stereo microphone in the M-S configuration. We used cuts from New York, Philadelphia, and Detroit, if I recall. We then dubbed to 16-track the selections on tracks 1-8, using 9-16 for our crossfade tracks. This way we could achieve continuity. During our dubbing to 16-track, I set up two rear speakers so that we could experiment with quad. By placing the audience tracks on the rear channels, you could feel the hall change from an 18,000-person arena to a 5,000- to an 8,000- when we would crossfade from the first eight tracks to the second eight tracks. It's a shame that quad wasn't available at this time, because it really sounded great that way.

PR: It has always been part of my feeling that a

live album should feel as close to a performance as possible, so that it plays. No fades, no dead cuts. It should feel as if a microphone was put up and a show was recorded. Nowhere should you feel a violent change of environment, or the technician's presence either. It should play as a concert.

PL: How about "L.A. Woman"?

BB: For that one, we went back to 8-track. It was pretty much recorded live, at their rehearsal hall at Santa Monica and La Cienega. There's a studio there now called the Upside Down Studio. We used a Langevin console and a 3M 8-track at 30 inches per second with AGFA tape. It was just a feeling that we all had — that we didn't want to do it in the studio. We recorded in their rehearsal room because that was the place where they were most comfortable. We had the pinball machine in there, so they could play it in between takes. As far as studio technique goes, it was a very simpleton album. It was recorded quickly and extremely simply, and it came off really well.

PL: What was the most difficult Doors' tune to record?

PR: "Unknown Soldier." My recollection is that it took an entire week to record.

RK: The first part was 150 takes.

PR: There were several problems with that song. If you listen to it, the overall sound and instrumentation change drastically from section to section, and so it was virtually impossible for it to be recorded as a piece. Today, with the newer technology and various switching equipment available to guitar and keyboard players, it could be done, but not then. I think it was recorded in four separate sections.

PL: How did you do the "execution"?

BB: That was mostly a sound effects man. He has a little box with a keyboard with maybe 12 buttons, which activate the same number of cassettes or cartridges. You plug your cartridges in, and you hit them when you want your sound to come in.

PL: So before he goes to a sound effects session, he has to prepare. He has to transfer from his master tapes down to those cartridges.

BB: Yeah. That "execution" was pieced together from various sets of cartridges. I think he had 20 different gunshots, and we listened to every one until we found the one we wanted. We did the same with the marches, and the gun butts, and the rifles cocking. Jim played the drill sergeant. It was really like old-time radio.

PR: Yeah. He has since died, but he was the most famous sound effects man in the movie and TV business.

That whole third album was much more difficult to do than the first two. It's the traditional group thing. With the first two albums, you're generally dealing with material that's been rehearsed and played for quite a while. Now if the group gets really successful, a strange phenomenon happens. The group is on the road a lot, and they run out of time to create and rehearse new songs. After you've used up the original bunch of material, you wind up with what I call the "Third Album Syndrome." When you've got a song that's only lightly rehearsed and you bring it into the studio, it takes much longer to get it down on tape and so you end up by doing a lot of overdubbing. "Waiting

for the Sun" was a heavily overdubbed album, whereas the first two were lightly overdubbed. It took months as opposed to days to record. The fourth album — "The Soft Parade" — took us nearly a year to do.

PL: On "The Soft Parade," whose idea was it to have the big arrangements?

PR: We did that because we thought that it was time for the Doors to have kind of a different sound. You know, if you present seven albums in a row with the same type of sound, it gets to be a bore. We thought "Let's take the Doors music to a logical extreme — a full band sound — so that we've got a place to go to from that." We created the furthest swing of the pendulum so that the fans could be relieved that we'd come back. It sounds calculated, and it was, but it was a way to keep it interesting. By the time we got to "Morrison Hotel," it's once again a very accessible, almost garage kind of sound. If the albums had gone "Strange Days," "Waiting for the Sun," the live album, and "Morrison Hotel," it would have felt very static. There would not have been that same show of development or evolution.

PL: To what extent did the Doors participate in the written arrangements?

PR: Pretty much what happened was we'd say "Okay, this song needs horns," so we'd call in an arranger and have a meeting with him, saying "On this part it should do something like this here and something like that there" — just very rough sketches. The arranger would then go away and write a chart. When we'd come back and do the session, it would always be wrong, and so we'd have to re-arrange it on the floor. That was primarily Robby and Ray, with a little help from me.

PL: How did the title cut come about? Did you originally intend it as a long piece with many sections?

RK: I think that Jim had written the poem — "The Soft Parade" — pretty much as it finally appeared, and the music was put to it later.

PL: Was it recorded in sections, or was that one basic track?

BB: It was done in sections. The various sections were recorded independently of one another, and we assembled them as we went along.

PL: Didn't you take a stereo lead vocal on that one?

BB: At the beginning, yes. I used the SM-69 again, and that's why it gives the uncanny feeling that Jim's right in front of you. We used stereo miking all over this album. I would say that "The Soft Parade" was the first rock & roll or popular music album to use stereo microphones.

PL: Am I correct in assuming that stereo miking was mostly used in classical music?

BB: Oh yes. They developed the microphone for themselves, and they didn't have any idea that popular music would ever want to use it. Stereo microphones were designed to be placed like 50 or 80 feet from a large orchestra, to give you a perspective like you're actually sitting in the auditorium. I would say that until recently, all microphones were designed for classical music. The only ones that were designed for pop were dynamic microphones. Now it's turned around and they're developing condenser mikes that can handle a lot of energy without folding over.

PL: How did you come to use stereo mikes on the "Soft Parade" album?

BB: Well, I had heard about stereo microphones and I always wanted to own one. When I was chief engineer over at Elektra, one finally came on the market and I bought it. I used it on everything I could. The Doors just happened to be the guinea pigs at that time. Bread too — there's a lot of stereo miking on their first album. In fact, it's one of the best examples of it.

PL: What are the advantages of a stereo mike over two well-placed microphones?

BB: Presence. With a matrix, you get more of a three-dimensional feeling. It enables a lot of time and space to happen. When it's set up properly, I could — if I could put a pair of earphones on you — walk around the microphone and you'd swear I'm walking around behind your head.

PL: How did you come to use all those lead vocals towards the end of the "Soft Parade" cut?

BB: I'm not sure. If I remember correctly, we had recorded five tracks of Jim's vocals. The five tracks were then ping-ponged in stereo to two tracks in a composite mix, so that everything would appear in its proper perspective during the mixdown. He appears left, left-center, center, right-center, and right on your "screen."

PR: What was amazing was that he didn't listen to any of the other vocals as he was recording. He could synch to the track all day long like that. He was an unbelievable syneher.

BB: The best I've ever recorded. The best.

PR: At the very end, Jim was just jamming and improvised several small pieces of poetry. We put them all together with switch editing.

PL: How did you first hear the Doors' songs, preparatory to recording them?

PR: Well, some I heard on stage, some I heard in rehearsal, some I heard in the studio, and some I'd hear where Robby would just pick up a guitar and say "Here's a new song." It happened all different ways. The later it got into the Doors' career, the more I heard the songs this way — as they were written.

PL: Did you ever influence the tunes as they were being written? Would Robby ever play you a song where you'd suggest a lyric change or another refrain?

PR: There were always things like that, but they were minimal. I've always tried to give the writers as much space as I possibly can. When Robby first played me "Touch Me," I didn't much like it. The main word in it was awful — it was a negative word. At that time, the main word wasn't "touch" — it originally went "Hit me, babe." He didn't mean "hit" in the violent sense, he meant it like "Gimme five." I said "Yeah, but the world won't know that. The world will think it's a sadistic song. When they hear it's the Doors, they'll think 'Aha, black leather and devices.'" I said that I'd put a soft word in — something that has positive rather than negative valence, like "touch." Morrison said "Hmm, not bad. Sexy too. Yeah, let's use that." That's one of the more dramatic instances where I'd suggest a change, but you have to realize that 98% of the time Robby's music and Jim's lyrics were fine to begin with.

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PHASING &

Since its invention or discovery in the mid 1960's, the special effect known as "PHASING" or "FLANGING" has been one of the most popular additions to the mixer's repertoire. Phasing was introduced to the mass audience in the song "Itchy-coo Park" by Small Faces and has been used (yes, and overused) to some extent by virtually every artist since that time. Just in case you've been on an interstellar voyage or in the Phillipine jungles since the 1960's, the phasing effect has been described by various individuals as "a swimming effect," as "a jet plane going through the music," as "a whooshing" sound, as "one of the best ways discovered to cover up mistakes," and as "something that makes you think the music is circling around you." All of these descriptions have merit.

The phasing effect's versatility can be partially explained by the following facts:

1. It affects three of the most important characteristics of a musical signal—pitch, amplitude, and harmonic distribution.

2. It affects signals over a very wide frequency range, and thus applies to virtually every signal source from a bass guitar to a snare drum.

3. It produces dynamic changes in pitch, which is interesting in itself and can be used to cover up mistakes.

4. It can be used to generate a pseudo-stereo signal with interesting characteristics and little effort (pseudo quad too).

5. When used tastefully it can add a hell of a lot of interest to a recording or live performance. (When used without taste it can *still* add a lot of interest. Short of running an entire concert through a phasing device, it's hard to misuse.)

WHAT IS PHASING?

WHAT IS FLANGING?

The terms "PHASING" and "FLANGING" have been used interchangeably to describe the effect obtained. In point of electronic fact, there are two substantially different ways of obtaining the effect, and the effect thus obtained is also substantially different. The original effect (used on Itchykoo Park) was allegedly obtained by feeding a signal into two tape recorders, mixing the output, and then

placing a drag on one of the reel *flanges* to slow down the machine. Because this method ties up two tape machines, requires 22 patch cords, and is a bit awkward (how many engineers have calibrated fingers?), several manufacturers designed electronic "black boxes" to achieve the effect with greater ease. Typically these devices accept a signal input and produce a phased output, the phasing being controlled by front panel knobs. One manufacturer (Eventide Clock Works) designed a unit specifically for recording studio applications. This unit has several methods of controlling the phasing: in addition to a front panel " $\Delta\Phi$ " control, it has provisions for using an internal envelope detector or a variable frequency oscillator, thus phasing automatically either by following the signal amplitude or in a repetitive fashion.

However, (and it's a big however) . . .

HOWEVER these black boxes, for technical reasons, could not generate the same effect as the finger on the flange. And although the black boxes had many advantages which could not (and cannot) be duplicated by the tape flanging method, the effect was not as pronounced or "deep," and thus the tape method continued to be used when a particularly strong effect was desired. To prevent confusion, in the remainder of this article we will refer to PHASING and FLANGING by the following definitions:

PHASING: The effect obtained by using electronic phase-shift networks to generate cancellations in the frequency spectrum of a signal.

FLANGING: The effect obtained by using differential delay to generate cancellations in the frequency spectrum of a signal, regardless of the method used to generate the delay.

The difference in the sound of the two methods can be well explained by theory, and we proceed to do so below.

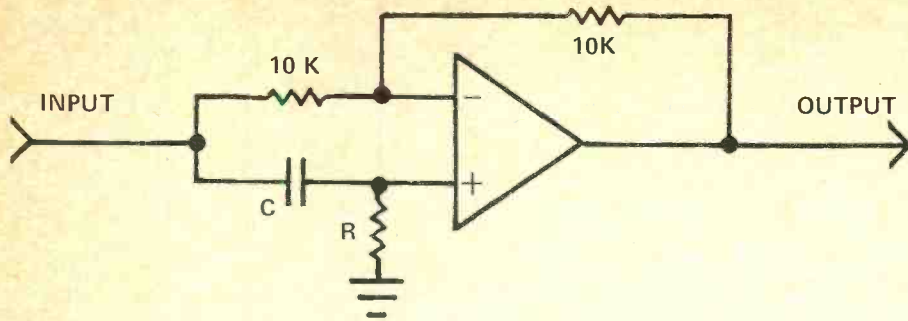
PHASING

The basis of the "black box" phasing device is an electronic circuit known as



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Eventide Clockworks, Inc.
New York, N.Y.

* reproduced from Eventide's Model FL-201
'INSTANT FLANGER' instruction manual.



the "ALL-PASS NETWORK." As one might assume, this type of network passes signals of all frequencies, but its output phase versus input phase varies as a function of frequency. A representative

circuit is diagrammed above. Since the circuit has a single RC time constant, the maximum phase variation, assuming ideal components, is 180 degrees. In actuality, it can only approach this value since C is limited by stray

capacitance and R must not exceed a reasonable value, depending upon the operational amplifier used. The output of the network sounds the same as the input (flat frequency response), but the phase is shifted according to the RC network constants. Thus, by adding the input of the network to the output of the network in a 1:1 ratio, the added signals will be reinforced at frequencies where the phase shift is near 0, and cancelled at frequencies where the phase shift is near 180 degrees. Since our example uses a single network, there will be no complete cancellation. To produce the phasing effect, several such networks are connected in series, and their phase shifts added. This gives rise to such advertising claims as "over 1200 degrees of phase shift!" which is true, impressive, and probably irrelevant. The other requisite for phasing is some method for varying the time constant of the networks over a wide range. In the example shown, varying R over a 400:1 range varies the cancellation frequency over the same amount, causing the phasing to shift from beyond audibility to the mid-bass region. As an added plus, during the period that R is changing, a frequency shift similar to doppler shift is created. This applies to the output of the all-pass network whether or not it is added to the input. Thus it is possible to generate a deep vibrato with no extra circuitry.

The frequency response of 8 all-pass networks is shown graphically for several values of R. The graphs are plotted on identical axes. Since the horizontal axis is logarithmic, the relative spacing of the nulls remains constant, although the absolute spacing in number of Hertz varies as R varies. In observing the graphs, note the following characteristics:

1. Below and above the ranges of the phase shift networks, the output of the system asymptotically approaches 2X the input.
2. The frequency ratio of the nulls is not constant and not harmonically related.
3. The shape of the nulls is sharp, the peaks rounded.
4. The total number of nulls is fixed and dependent upon the number of all-pass networks.
5. At any time the nulls are clustered within one portion of the frequency spectrum.

FLANGING

As we stated earlier, flanging is produced by mixing the output of two tape recorders, one of which is running a little slower than the other. Since the head-to-head distance is fixed, the transit time of the tape from the record head to the play head determines the path delay. Assume that the speed difference between tape machines is such that the differential delay between transit times is equal to 1 millisecond. Since one millisecond is the period of a 1kHz signal, it might be

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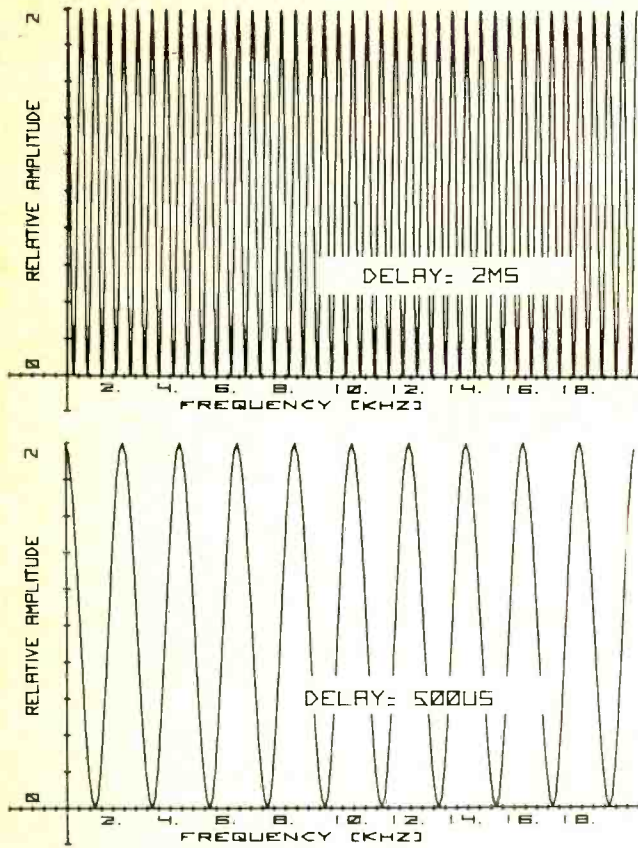
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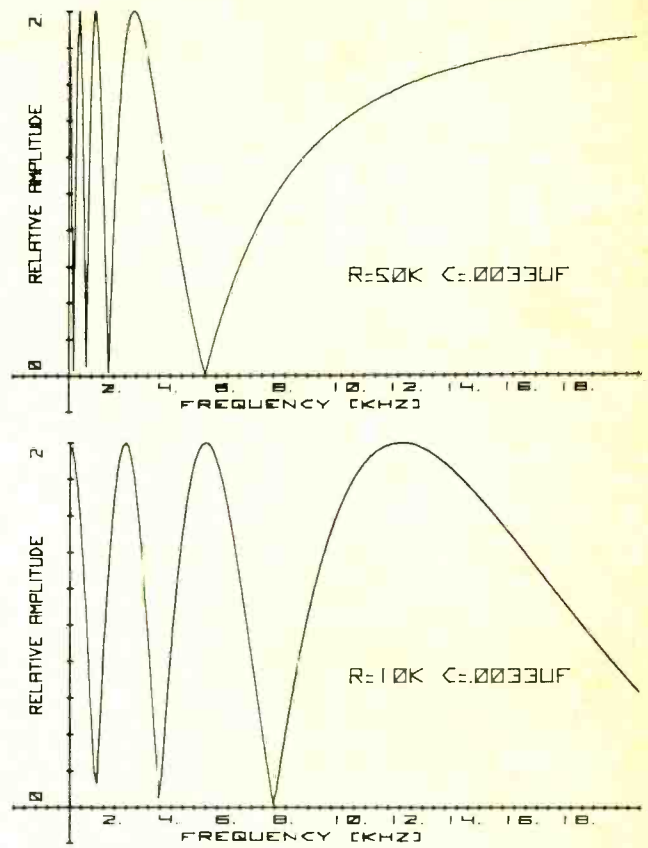
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PLOT OF FREQUENCY vs. AMPLITUDE OF VARIOUS DELAY TIMES (left) and PHASE NETWORKS (right)
 (In each case the graphed response is obtained by the algebraic addition of the input signal to the processed signal.)

Signal processed through true delay circuit with delay as shown



Signal processed through 8 identical networks with R-C constants shown



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expected that a 1kHz input to the system would result in an additive signal, since the two outputs would add in-phase. On the other hand, a 500Hz input would have a 180 degree phase shift at 1 millisecond delay, and thus would completely cancel. Slightly less obvious is the fact that all signals at odd multiples of 500 Hz will undergo the same cancellation, since, for instance, the phase shift of 1500Hz is $360+180$ degrees at 1 millisecond delay. Several graphs are presented showing the frequency response of a signal mixed with its delayed replica. Incidentally, all the graphs show the steady state response. We'll have a few words on transients later. In observing the graphs, note the following characteristics.

1. Below the first null, the output of the system asymptotically approaches 2X the input. There are always nulls at high frequencies.
2. The frequency ratio of the nulls is constant and harmonically related.
3. The shape of the nulls is uniform, and similar to the peaks.
4. The number of nulls increases as the delay increases.
5. At long delays, the entire frequency spectrum is substantially modified.

COMPARISON

The consequences of the differences in characteristics are striking. Intuitively, one can feel that the flanging response should have more effect on the music, and in this case intuition is correct.

1. Because there are always nulls at high frequencies, the "jet plane" effect is more pronounced, even when the delay is fairly long.

2. Because the nulls are harmonically related, the effect on the tone of many instruments is more musically interesting. For instance: Assume an instrument is being played with a fundamental frequency of 440Hz. It will have harmonics at 880Hz, 1320Hz, 1760Hz, 2200Hz, etc. At a delay of 1.136 milliseconds, the fundamental and all odd harmonics will be cancelled out, leaving only the even harmonics. If the instrument shifts pitch, its entire tonality will change.

3. There's nothing much that can be said intuitively for advantages of sharp or rounded peaks, and since there's no simple way of comparing them subjectively, let's pass on this one.

4. The number of nulls increases as delay increases, and thus there is an overall broader effect on the input signal. It should be noted, however, that when the nulls are very closely spaced, the effect decreases since there is an averaging between the nulls and the peaks in psycho-acoustic realms. As a practical matter, useful flanging occurs in the delay range of 50 microseconds to about 5 milliseconds, and devolves to a doubling effect after about 15 milliseconds.

5. Same comments as above.

The above comparisons refer only to the steady state behavior of the phasing/flanging systems. In reality, two transient conditions occur (and interact). At issue are the subjective effects when:

1. Material is being phased or flanged while the *time constant or delay of the network is being varied*; and
2. *The input is being changed* while the constants of the network are held fixed.

The results in the first case were alluded to earlier. If a phase shift network has its constants changed, a frequency shift analogous to doppler shift will occur. Since the networks do not affect all frequencies equally, the change will be different for different frequencies. Thus, harmonic ratios will not be preserved during the change. On the other hand, changing the delay in the case of flanging is *precisely* analogous to doppler shift, and frequency shift will take place in the well-known manner. Subjectively, it appears that the *rate* at which the doppler or pseudo-doppler shift takes place is more significant than the type of network that produces it. This is only the result of a few hurried observations and you should feel free to disagree with this conclusion.

Far more interesting is the second case. A phasing network can produce only a limited amount of delay at frequencies in the range that is of musical interest. Transient effects arise because the signal applied to the network input does not affect the final result until it reaches the end of the network. The other branch of signal is direct. For instance, if the delay time were 5 milliseconds and a 1900Hz signal were applied to a flanging network, the output would be a null as indicated in the graph, but, before the null was achieved, 9 complete cycles of the tone would pass through the network, resulting in a cross between a click and a short "beep." Actual musical signals are not nearly so deterministic, and the subjective effects are impossible to describe. That's one of the main reasons why the flanging effect is more pronounced than phasing. In effect, each signal has two characteristics — its steady state and its transient. Although this does not apply particularly to violins, organs, etc., plucked string instruments, and especially drums, take on a whole new aspect when flanged. This effect becomes distinct from the frequency nulling at about 1 millisecond, and increases in importance up to about 5 milliseconds.

In summary, then, the comparison between phasing and flanging comes down to this: Flanging produces a more pronounced effect, primarily because of the extra nulls in the frequency response, and the longer period before transients are nulled out of the final result. It is more difficult to achieve because of the bulky equipment and inconvenient setup and not as controllable.

Reread that last sentence. It's a lie.

FLANGING FOR THE MILLIONS

It seems that achieving short delays in signals has always been difficult. How would you build a delay line variable from, say, near 0 to 5 milliseconds?

If you need a short delay, you can use distributed capacitance and inductance of a coil of wire. As the delay increases, however, the bandwidth suffers. Above a few tens of microseconds, it becomes unusable for high quality audio.

If you need a very short delay, you use a piece of wire and wait for the speed of light to bring you your signal.

If you need a very long delay, you record your signal on tape and play it back later.

If you need a super long delay, you inscribe the data on a silicon wafer and send it into a solar escape orbit.

If you need a few hundred milliseconds of delay, you convert your signal into digital format and store it in shift registers. It will come back unaltered after the desired delay and be converted to analog and reused.

But what about five milliseconds?

The delay is too short to justify the overhead cost of digital technology. A speaker at one end of a tube and a microphone at the other? Fine for fixed delays but try to adapt it for rapid variation! Ultrasonic delay? Suffers from dynamic

range problems, and how to vary it? Tape delay? Works, but what a nuisance! Magnetic disc? Costs a fortune and has (ugh) moving parts.

Enough teasing. A new type of semiconductor has been produced in recent years. It is known generically as the "Charge Coupled Device" and popularly as the "Bucket Brigade" delay. Until very recently, the state of development of these devices was such that they were impractical to use for audio. They had insufficient dynamic range and suffered from many undesirable electronic characteristics beyond the scope of this article. As this is written, at least one device is available which is suitable for short delay use in audio with sufficient range, both in delay and amplitude. Earlier devices had been designed primarily for video applications which are more demanding at high frequencies but can get along with 40dB range.

Using these devices to generate delay enables one to build an all-electronic (no moving part) "black box" which produces flanging in a manner precisely analogous, but without the bulk and inconvenience, to the two tape machine-22 patch cord method. An additional benefit is that the delay is controlled electronically instead of mechanically, enabling one to do the same sort of tricks, such as signal or oscillator controlled flanging, as can be done by the common phasing unit.

APPENDIX

For you mathematics people, the formulas used to create the graphs shown are given below.

PHASE RESPONSE OF ALL-PASS NETWORK

$$\Theta = (-2 \tan^{-1} \omega R_1 C_1) + (-2 \tan^{-1} \omega R_2 C_2) + (-2 \tan^{-1} \omega R_n C_n)$$

FREQUENCY RESPONSE OF ALL-PASS NETWORK

$$H = \sqrt{(1 + \cos \Theta)^2 + (\sin \Theta)^2}$$

FREQUENCY RESPONSE OF SIGNAL ADDED TO ITS DELAYED REPLICA

$$H = \frac{\cos \frac{(T_d)(360)}{1/f} + 1}{2}$$

WHERE:

R is the resistance component of the all-pass network

C is the capacitance component of the all-pass network

ω is the frequency in radians/sec ($2\pi f$)

T_d is the delay time in seconds

f is frequency in Hz

- END -

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RELAPPING YOUR OWN MAGNETIC RECORDER HEADS — Why — When — How

by RONALD G. KINZIE
WMBI
Chicago, Illinois

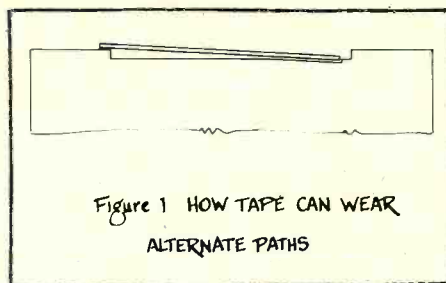
Relapping of tape heads is not as difficult a task as may first appear. The only materials needed for the job are abrasive sheets and a piece of plate glass for backing. The mechanics involved (described later) are not difficult and can best be learned by practicing on an old head. Should you want to try your hand relapping tape heads, a half an hour each should probably be allowed for your first two or three, but as proficiency is gained, it is entirely possible to relap a head (1/4 inch tape size) in about fifteen minutes.

Why Relap?

Relapping may be decided upon for one of several reasons. The decision to relap was made at WMBI when it was found that certain types of heads, when well grooved, had a much greater tendency to collect oxide from tape than those heads showing little wear. Chief offenders in this case were stereo heads which used non-metallic materials in the construction of the head face. Keeping grooved heads clean was rapidly becoming an impossible chore, and once a given head began to show signs of becoming a *dirt collector*, it seemed nothing could be done to correct this chronic condition. Even frequent cleaning throughout the day could not keep pace with the increased problems of drop-out in one or both channels.

More often than not, the oxide would collect primarily in the corners of the groove, causing the tape to ride up out of the groove on one side or the other. Thus, an additional problem was created as the tape would begin to wear an alternate path in the head. (See Figure 1.) Unfortunately, once such an alternate path was sufficiently established, the tape would not stay in one path, but would jump from one path to the other without

warning. Neither would a subsequent, thorough cleaning of the head remedy this problem once the alternate path had been established.



A simple test will reveal whether or not an alternate path does exist: first skew the tape one way, allowing the tape to slide into the groove from one direction; and then skew it the other way, allowing it to slide into the groove from the other direction. If a new path has been worn, it is easy to tell when the tape is in the newly formed path because then, a marked drop in level in one or more channels will be evident. The drop is a result of the loss of good tape-head contact for those channels.

At this point the questions may arise, "How much additional life could be expected from a reconditioned head?" and "Is it worth it?" A practical way to answer these questions, for yourself, may be to keep a record of the amount of wear on a head at the time of relapping and the date. (Sometimes it is convenient to attach this information to the head on a gummed label.) As data is collected, you will then be able to evaluate the worth of such a project, given your set of circumstances.

It should be mentioned here that the geometric shape of the head face also

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plays a significant part in expected head life (explained elsewhere in this article).

The Relapping Process

Basically, the lapping process is done in seven steps using increasingly finer grades of abrasive material throughout the process. This involves using two grades of medium grit finishing paper to remove metal and to reshape the head, and then five grades of lapping film to restore the polished surface. (See Table 1.)

The head should be made ready for lapping by removing it from its mounting block, if one is used. The various grades of abrasive paper (or lapping film) may then be placed back-side-down on a desk top covered with plate glass. The only exceptions are steps 6 and 7, which are carried out under running water. In steps 3 through 5, water is used between the lapping film and the glass. The water will hold the lapping film firmly in place and keep it in a smoothed-out condition. Next, more water is added to the abrasive side of the lapping film in order to keep its surface from getting clogged.

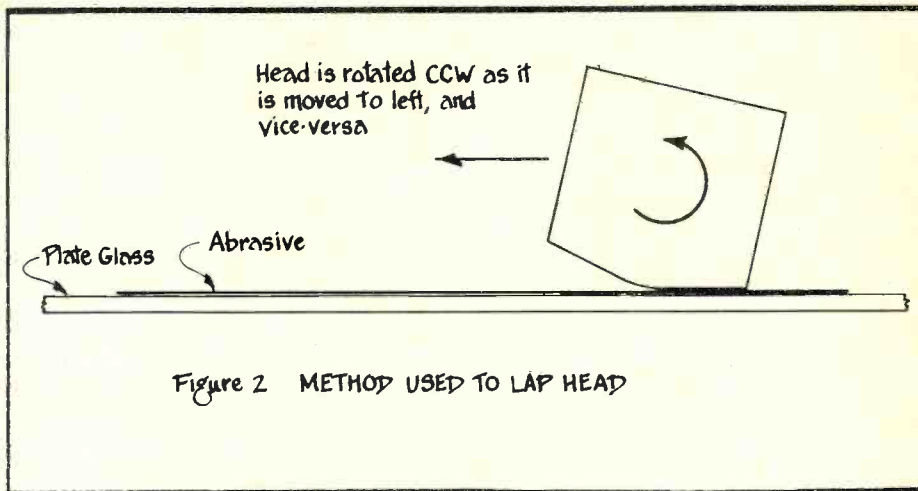
The lapping process is carried out by slowly rotating the head first one way, and then the other, as it is moved back-and-forth across the abrasive sheet. (See Figure 2.) Rotating the head constantly as it moves prevents the wearing of any flat spots on the head face.

As the head is lapped, as little pole metal as possible is removed, yet enough to completely remove the groove. (See Figure 3.) It is suggested that metal be removed from the face of the head in such a way as to approach a rounded (cylindrical) surface, as opposed to a more pointed surface which is found on some original equipment. This rounded surface seems to give a much longer expected wear life to the head.

TABLE 1
THE VARIOUS STEPS AND ABRASIVES USED IN THE LAPPING PROCESS

STEP	ABRASIVE MATERIAL	GRADE	NOTES
1	Aluminum oxide paper (open coat)	120-C	1 4 5
2	Aluminum oxide paper (open coat)	220	1 4 5
3	Aluminum oxide lapping film	40 micron	2 4 6
4	Aluminum oxide lapping film	30 micron	2 4 6
5	Aluminum oxide lapping film	12 micron	2 4 6
6	Aluminum oxide lapping film	3 micron	3 6
7	Aluminum oxide lapping film	0.3 micron	3 6

1. No water is used in grinding process.
2. Water is used between plate-glass backing and abrasive sheet as well as on cutting side of abrasive sheet.
3. Both lapping film and head are held under running water during polishing process.
4. Plate-glass backing is used with abrasive sheet.
5. Basically a shaping process.
6. Basically a polishing process.
7. Finer polishing.



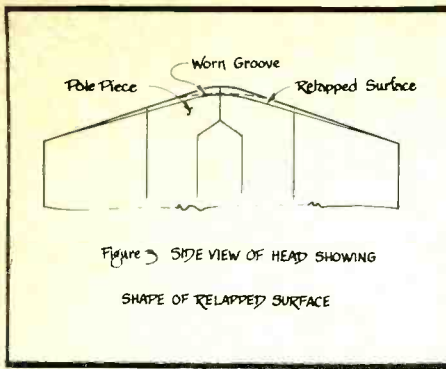
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After the shaping process, finer abrasives are used to restore the polished surface; the same mechanical motions being used as when shaping. Care should be taken to avoid contaminating each grade of abrasive with any of the coarser grits by thoroughly rinsing the head being lapped under running water between each stage of lapping. The final two stages of lapping are actually carried out under running water to prevent any possible contamination by stray grit.

The head is then dried and remounted in its mounting block. In addition to tightening any set screws in the mounting block, the head may be cemented in place with Super Strength Lock n' Seal (a Loctite product) to provide additional strength and stability. Loctite should not be permitted to come in contact with the threads of the set screw.

The erase head does not seem to be subject to the same ills as the record and play head, possibly because perfect tape-head contact is not critical. For this reason, I have not found it necessary to relap an erase head to date.

At this point, the head may be installed in the tape machine. The machine should be aligned both mechanically and electronically in the same fashion as when new heads are installed.

Materials

Aluminum oxide lapping film can be purchased from 3-M. The current price is \$45.00 for 100 9" x 11" sheets. (This is the minimum order for this type of abrasive.) This may seem like a substantial investment for abrasives, but it is less than the price of one head and, considering the small amount used per head, should last indefinitely.

An initial order might consist of:

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30 sheets	30 micron
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15 sheets	3 micron
15 sheets	0.3 micron.

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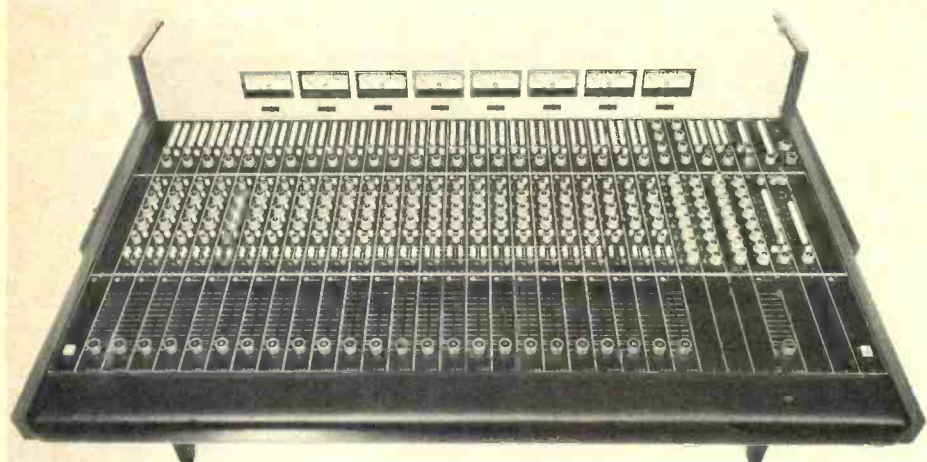
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CERWIN-VEGA INTRODUCES COMPACT MM-3/V-30 PA SYSTEM

The system, consisting of an 8 channel mixer-amplifier and two of the company's best selling V-30 speaker systems, carries a suggested retail price of \$1,798, and is designed to offer higher performance and more useful features than other popular systems in its price range.

The MM-3's built-in power amplifier uses the same rugged circuit as used in the EARTHQUAKE Sensarround amplifiers, and develops 275 watts RMS at less than 0.25% distortion. The mixer section has such unusual features as a switchable 20 dB pad on each input to prevent pre-amplifier overload, a built in professional quality peak limiter calibrated to limit at the power amp's clip point, and a unique "Preview" system that allows the operator to select any channel or combination of channels for monitoring through the headphone amplifier. The unit's built-in reverb electronics can double as a separate monitor mixer if desired. A special "Freq-Out" circuit gives effective control over feedback with just two controls, without

AENGUS
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SCOTT LABS.
SESCOM
SHURE
SONY
SOUNDCRAFTSMEN
TASCAM
TEAC
360 SYSTEMS
UREI

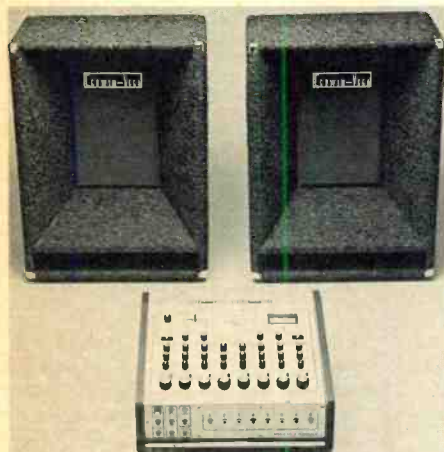
DAVE
KELSEY
SOUND

(213) 937-1335

6912 melrose avenue
hollywood, california 90038

Circle No. 132

affecting the tonal balance of the desired program. A complete array of inputs and outputs allows patching in a wide variety of accessories (i.e., graphic equalizers, electronic crossovers, effects devices, etc.) and with the addition of extra amps and speakers, a multi-kilowatt system may be assembled.



The V-30 speakers supplied with the system consist of a high power 15" woofer and burnout-protected cast high frequency horn in a cabinet measuring 30"H x 24"W x 16"D, the V-30 is said to be at least 4 times as efficient as typical PA columns, with wider (60-16000 Hz) response.

The MM-3 mixer-amplifier has a brushed aluminum front panel with color-coded knobs and wood grain case. Available soon will be an accessory input panel converting all 8 inputs for low impedance operation, with provisions for a plug-in umbilical cord for remote mixing.

For further information contact: ROB LEWIS (213) 769-4869. CERWIN-VEGA, 6945 TUJUNGA AVE., NORTH HOLLYWOOD, CA 91605.

Circle No. 133

HAECO PL-2 LOW COST LIMITER

The new high quality PL-2 limiter is price designed to solve the studio and sound reinforcement problem of, "never enough limiters around." Featuring a full +24dB output, with totally variable threshold and release times, the PL-2 is a photocell type of unit with the soft sounding characteristics of higher priced limiters.



The following are the manufacturers specifications: 1½"Wx6-3/8"H x 5½"D size; controls - front: compression threshold, release time, VU meter (reads true gain reduction), rear: meter zero calibrate, gain reduction bias; freq. response 15Hz - 30kHz ± .5dB; distortion @ limiting threshold, less than .5% nominal, less than .15%; max. output +24dBm (using 50 V power supply); noise -85dBm @ any gain setting from unity to +30dB; gain structure: unity to 30dB (adjustable internally).

Input impedance more than or equal to 2.5k ohms. Output impedance 6 ohms to be driven into 100 ohms or greater. Attack time 500 microseconds; release time variable 300 m.sec. to 5 seconds. -35 to -50 v DC voltage required. Features low cost, low distortion, ease of operation, ease of servicing, drift-free operation, lamp/LDR gain reduction element.

Price: \$100.00.

HOLZER AUDIO ENGINEERING CORP.
14110 AETNA ST. VAN NUYS, CA.
91401, (213) 787-7733.

Circle No. 134

MODULAR AUDIO BI-POLAR POWER SUPPLY

A new high output current bi-polar power supply, with output current capability of ± 4 amps is now available.

Known as Model 7000, it operates at 115 VAC, 60Hz input power, and provides adjustable dc voltages from ± 14 to ± 16 V at 4 amps. The unit provides crowbar over-voltage protection (limiting the output to 18 volts maximum); fold-back type current limiting; and interlocked output protection.



Other features include remote sensing, resettable power line circuit breaker, an overload indicator, and front panel voltage adjusting controls.

The Model 7000 measures 5" x 8-9/16" x 12-1/4", and is designed for bench or rack mounting. A separate rack panel is available for mounting one or two units in a standard 19" rack, 5" high. Delivery is from stock to 60 days.

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

Circle No. 135

SPECK SP-800 CONSOLE

The SP-800 is a 16 input, 8 output console with an independent stereo mix buss. The console incorporates an 8 track

monitor and pan section that features automatic sync and program monitoring.

Each input channel has XLR balanced inputs, 10 and 20dB attenuation to the preamp section, low and high frequency equalization with 20dB of boost or cut, 8 position rotary assignment switch, cue and echo send control, a conductive plastic slide fader, and a line/mike input switch on the first 8 channels.



The output section consists of 2 echo returns, a stereo master fader and 8 rotary submaster controls that are metered to +4dBm at 0 VU. All output lines are transformerless and are designed to drive 600 ohm loads with a distortion figure of .1% or better at +20dBm.

Retail price: \$2,555.00.

SPECK ELECTRONICS, 11408 COLLINS ST., NORTH HOLLYWOOD, CA 91601.

Circle No. 136

ROBINS PROFESSIONAL-SIZE BULK TAPE ERASER

A new degausser to erase professional and industrial-size reels of magnetic tape as well as digital cassettes is the new rugged unit, of heavy-duty construction, that will demagnetize reels up to 1" wide and 17" in diameter. A number of safety features protect the eraser, Model R24024, while insuring a powerful degaussing field. A forced air cooling system provides a relatively long use cycle.



Operating on 115v AC, 50-60 Hz, 18 amps, the R24024 is capable of degaussing 100 reels of ½" tape in approximately 15 to 30 minutes. One-inch reels are handled by doing one side and then flipping over the reel to repeat the erasing operation, which is simply to place the reel on the spindle, turning on the main power switch and slowly rotating the reel,

PHASING vs FLANGING

the discernible difference

Phaser: An effects component designed to produce a phase-shift response created by a comb-filter effect with frequency-related notches which is mixed back with the original signal.

The effect of phasing is obtained by passing the input signal through a series of all-pass filters exhibiting a phase response that is variable in frequency. When this signal is mixed back with the input signal, cancellations and reinforcements occur. The resulting comb-filter effect spreads over a wide range of frequencies. As these notches are moved up and down the audio range, a spacious, spinning effect is obtained.

The subjective effect of phasing is best at mid and low frequency ranges, as opposed to flanging, phasing's chronological predecessor.



Flanger: An effects component created by MXR Innovations to provide repeatable reel-flanging effects, caused by mixing a dry and a time delayed signal to create a comb-filter response with harmonically related components.

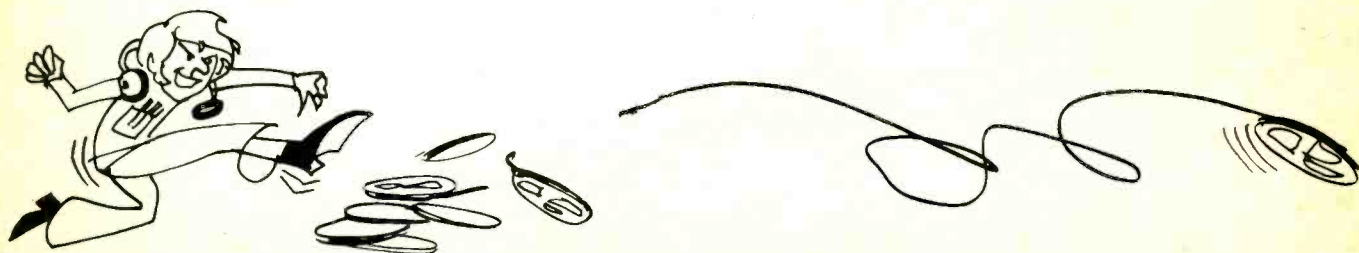
The effect of flanging is created by mixing a variable time delay signal back with the original dry signal. The resulting comb-filter response is characterized by the precise mathematical relationship created by the time delay.

The subjective effect is that of conventional reel-flanging, without the necessity for manpower and multiple tape decks or a costly and highly specialized digital delay system. The comb-filter response of flanging causes random program material (i.e. drums, cymbals and other percussion) to take on musical tonality. Unlike phasing, flanging is subjectively more noticeable at mid and high frequencies, due to the time delay created response. Unlike reel-flanging, the MXR Auto Flanger is at the tip of your fingers in real time.

You will find the **Auto Flanger** and **Auto Phaser** to be wise additions to any studio effects board. Compact and fully compatible with existing systems, both components are easily incorporated with the mere addition of a simple power supply (+15 to +30V).

Once installed, the units' ease of operation and versatility will revolutionize your effects board.

External control capabilities allow for stereo operation of two units, and low power consumption ensures multiple use without excessive drain on your board supply. Both units are durable, reliable, affordable . . . innovative—and are internationally available at leading audio supply houses.



MXR Innovations, Inc.

Professional Products Group, 277 N. Goodman St., Rochester, N.Y. 14607

Circle 110. 137

R-e/p 53

at a constant rate, for three or four revolutions.

Robins' caution to customers graphically illustrates the R24024's strength. "Any device whose operation can be adversely affected by a magnetic field should be kept at least two feet away from the unit," it says. "This includes such items as magnetic tapes or films with sound tracks, hearing aids, pacemakers, electronic watches and test instruments."

In normal use, the new Robins bulk tape eraser may be operated for 40 minutes continuously, before requiring a 10-minute cooling off period.

Safety features include automatic over-heat phase, indicated by a panel light, during which the magnetic field is automatically shut off but a cooling fan continues to run, a three-conductor power cord, fuses and pilot light.

Model R24024 carries a professional net price of \$240.

ROBINS INDUSTRIES CORP., 75 AUSTIN BLVD., COMMACK, L.I., NY 11725.

Circle No. 138

AURATONE ULTRA-COMPACT-SOUND-CUBE MONITOR SPEAKERS

Used in many prominent recording studios for comparative monitoring, where engineers need to evaluate mixes on small speakers, the Model 5C Super-Sound-Cube™ has been refined both on performance and appearance.



According to the manufacturer, acoustical testing of the 6½" x 6½" x 5¾" Model 5C shows the ability to handle a continuous 30 Watt input at 150 Hz, with up to 60 Watt peaks in program material without blowing.

With an audible response range from 50Hz to 15,000Hz the units measure plus or minus 3½dB in the vital 200Hz to 12.5kHz range.

The Model 5C is also said to be very useful as a comparison standard speaker, being easily moved by the mixer or producer from a known monitoring environment to an unfamiliar control room. The units are also said to be recommended for monitoring on remotes.

Price: \$50.00 per pair, retail.
AURATONE, P.O. BOX 580, DEL MAR, CA. 92014, (714) 453-2334.

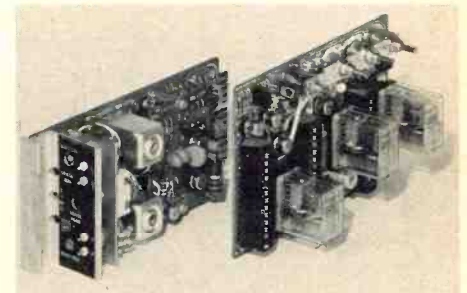
Circle No. 139

AMPEX ANNOUNCES NEW MM-1100, AG-440 RECORDER ACCESSORIES

VOIDLESS PUNCHOUTS FOR MM-1100 AND AG-440

A new accessory which assures clean insert edits in multichannel recording is being offered by Ampex Corporation for use on its MM-1100 and AG-440 audio recorders.

Called Pick Up Recording Capability (PURC), the accessory permits the editing or dubbing of new material over previously recorded material without creating errors at either end of the new insert.



Typically, during a dubbing sequence both the erase and record heads are activated simultaneously. Because of the space between the two heads, over recording occurs on the unerased tape. Likewise, a gap is left at the end of the dub.

By individually controlling the turnon and turnoff operations of the erase and record heads, PURC prevents over recording at the punch-in position and eliminates the resulting gap or blank spot at punch-out.

Prices range from \$170 to \$675. The PURC accessory is available within 60 to 90 days.

Circle No. 140

NEW SYNCHRONIZER FOR MM-1100 OR AG-440

Ampex Corporation today introduced an electronic device designed to link the MM-1100 and AG-440 series recorder/reproducers with the RA-4000 automatic programmer for use in multitrack audio production.

The device, Auditec II, permits the multiple tracks of voice, music and sound effects to be recorded and mixed in synchronization with the video.

Through interface with the recorder and programmer, electronic splices may be set up, previewed and executed immediately, or maintained in memory so that entire audio-video edit sequences may be accomplished in a single continuous operation.

One track of each recorder is used for a digital synchronization code, leaving all remaining tracks for record and mixdown of the desired master audio recording for video broadcast.

For each multichannel recorder linked to the RA-4000, one Auditec II is neces-

COMPLIMETER™



MODEL 610

Used in recording studios; disc mastering studios; sound reinforcement systems; TV, AM, FM broadcast stations to maintain a *sustained average signal* at a level *significantly higher* than that possible in conventional limiters, and with performance that is seldom attained by most *linear amplifiers*. Rack mounted, solid state, functional styling, the Model 610 is in stock for immediate shipment.

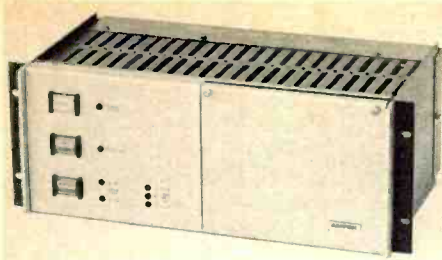
Specifications are available from:

SPECTRA SONICS

770 WALL AVENUE, OGDEN, UTAH 84404
(801) 392-7531



Circle No. 141



sary. After installation, the MM-1100 or AG-440 recorder and the RA-4000 can be used for all original functions.

Priced at \$6,500, the Auditec II fits both a standard rack and in the MM-1100 overbridge.

Circle No. 142

OVERHEAD RACK SPACE FOR MM-1100's

A new overhead accessory bridge is now being offered by Ampex Corporation for the MM-1100 series recorder/reproducers.

The modular design allows up to 100 pounds of accessories to be easily installed on all MM-1100s. Only 19½ inches wide with risers 3-1/3 inches high, the entire assembly can be mounted at the rear of the MM-1100 controls.



Up to four sets of risers may be installed, for a total of 14 inches of vertical rack space.

Some of the accessories that can be installed in the overhead bridge are the Auditec II, the Sync lock, the VS-10 Variable Speed Oscillator, and EECO Synchronizing equipment components.

The overhead accessory bridge comes in kit form and costs \$975.

Circle No. 143

NEW SEARCH-TO-CUE ACCESSORY

The unit is designed to cut costs of mixdown and overdubbing operations in professional recording studios and will enhance their overall multichannel recording capability.

Search-to-Cue comes in kit form and can be easily installed by a qualified technician. The kit is priced at \$895 and

availability is 90 days a.r.o.

The device permits the operator to set a cue anywhere on the tape, then return to that point automatically. This point can be set in either the fast forward or rewind modes as well as in the stop mode.

Since the timer is tape-driven and is independent of the Search-to-Cue logic, the timer readout remains unaffected no matter how many times the cue may be reset.

Conversely, if the timer readout is reset with the display reset button, the operator can still return to the previously set cue. A new cue is set, clearing the old one, by manually going to the desired point on the tape and then pressing the cue button.



Position of the tape is shown on a digital display while a (+) or (-) display indicates whether the current reading is ahead of or behind the zero point.

When searching to the cue point, tape speed is controlled automatically to prevent overshooting. Timing is accurate to ±0.5 second at 15 inches per second (ips).

As a further convenience, the operator may press the cue control on the Search-to-Cue accessory and then the play control on the tape transport. When operated in this manner, the MM-1100 will shuttle the tape to the cue and immediately go into the play mode. The operator may also override the cue control at any time by pressing the stop button and then any other transport control.

Circle No. 144

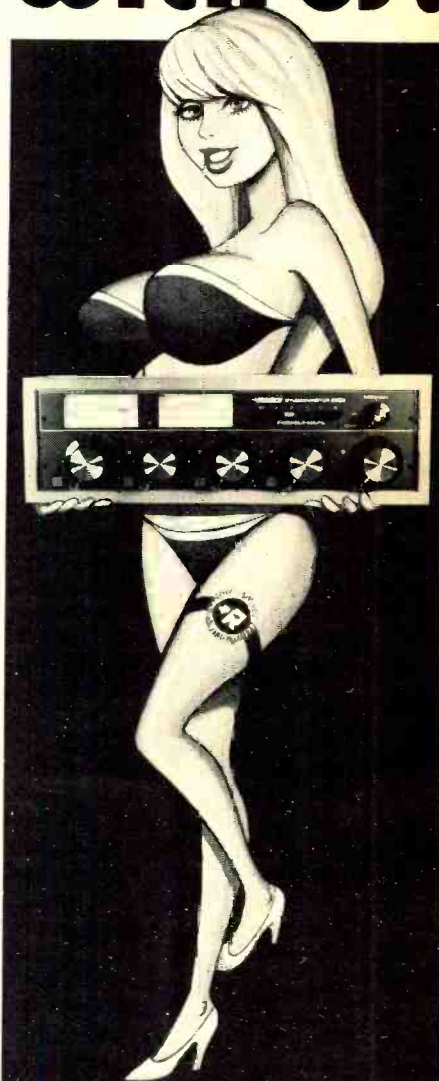
NEW CONSTANT TAPE TENSION ACCESSORY

Ampex Corporation has introduced a new Tape Tension accessory for its AG-440c series studio recorder/reproducers.

Designed for 1/4" and 1/2" tape the



mix it with us!



Good Looks & Great Performance are yours with the **RUSSCO STUDIO/MASTER 505 Audio-Mixers!** 5 mixing channels, 4 channels each with built-in preamps, each adjustable for mic, phono or hi-level, and the 5th channel has 5 hi-level push-button inputs! The monaural version has a built-in monitor amp! Built-in cue speaker, cue on any channel! Push button key switching & LED indicators! Built-in headset amplifier, Allen-Bradley Mod Pots, FET monitor muting! Available New in Stereo or Monaural, Cabinet or Rack Mount!



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Phone (209) 299-2167

Circle No. 145

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can be a Real Time
Audio Analyser.
Add ARA-412.**



**ARA-412
Acoustic
Response
Analyser.**

Now you can perform Real Time Audio Analysis with just three things — (1) your dc oscilloscope, (2) a "pink noise" source, and (3) the new ARA-412. This unique, easy-to-use instrument permits you to test microphones... isolate cross talk... balance crossovers... check loudspeaker deficiencies... test tone controls... adjust equalization... and much more. The ARA-412 is priced at **\$1,450**

For additional applications, write for the free ARA-412 data sheet: (FOB San Diego)

**COMMUNICATIONS
COMPANY
inc.**



3490 Noell Street
San Diego, CA 92110
Telephone (714) 297-3261

Circle No. 146



**This is a
three band
continuous sweep
equalizer.**

It is
quiet [-80dbm],
small [9" x 7" x 2"],
and costs

\$163.50

For spec's
call or write



Professional Audio
11408 Collins
North Hollywood,
California 91601
(213) 980-9919

Circle No. 147

TS-40 accessory insures constant tape tension throughout the entire playback cycle.

Available in kit form for easy field installation, the TS-40 handles supply reel tape pack diameters from 1-3/4" up to 10-1/2".

Priced at \$300, the Ampex TS-40 is available immediately.

Circle No. 148

AMPEX CORPORATION, 401 BROADWAY, REDWOOD CITY, CA 94063.

**SPHERE ELECTRONICS ANNOUNCES
NEW ALPHA I & II PRO-QUALITY
MIXING CONSOLES**

Equipped with 8 input channels, the ALPHA I has stereo outputs and the ALPHA II features 4 mixing busses. Designed for broad use in Television, Film-Sound, and all Recording work, the small size (22"W, 23"D, and 9"H) combined with numerous functions makes it an ideal remote mixer or equally at home as a permanent sound system. Professional quality throughout, the ALPHA series



contain long-throw, conductive plastic faders, solo input, program echo and return, independent cue mix, program echo pan (optional 2 or 4 buss assign color-coded and illuminated pushbuttons), full monitoring control, and an optional Hi/Lo equalizer — all housed in an expendable input, attractive, new package. Self-powered and XL's in and out. Write for descriptive literature on this innovative system.

SPHERE ELECTRONICS, 20201 PRAIRIE "A", CHATSWORTH, CA 91311.

Circle No. 149

**ASHLY EQUALIZER FEATURES 3
ADJUSTABLE PARAMETERS, SELF-
CONTAINED POWER SUPPLY, ALLOW-
ING MAXIMUM FREEDOM OF PORT-
ABLE USE**

The model SC-6 Parametric Equalizer is designed for maximum freedom of use, featuring a self-contained power supply and rugged construction for high reliability and long life. Four bands cover 16Hz to 25kHz, with not only adjustable frequency and gain, but also adjustable curve shape ("Q"), allowing much greater freedom of correction than a graphic equalizer. Very low distortion (less than .01% THD) and noise (-95dB eq. out. -85dB eq. in) levels make the unit equally useful in remote or studio applications. The unit may be



mounted almost anywhere due to its light weight (5 lbs.) and small size (no dimension exceeds 7 1/2").

Suggested applications for the SC-6 include feedback control, acoustical correction, loudspeaker correction, tape to disc transfers, dialogue equalization, and generation of special effects.

The unit lists for \$375.00, F.O.B. Rochester, New York.
ASHLY AUDIO, INC., 703 ATLANTIC AVE., ROCHESTER, NY 14609.

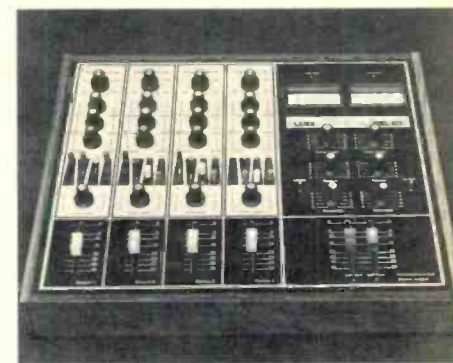
Circle No. 150

**LAMB LABORATORIES SERIES
PML422 MIXERS**

Revox Corporation introduces its new Lamb Laboratories PML422 series — the PML422 is a four input, two output unit incorporating input sensitivity preselection, separate low, mid and high frequency equalizers, echo send/return controls and adjustable output limiters.

The PML424 is the mirror image version of the PML422 designed to increase capability to 8 input, quad/4 or 2 output.

The PML426 provides six input channels — thus combined with the PML422 or the PML424 10 input, quad/4 or 2 out configuration can be achieved.



All three mixers incorporate quad pan faders in each input source channel.

The PML426 can be incorporated with either the PML422 or the PML424 and combining all models will give a 14 input quad/4 or 2 out configuration.

Revox Corporation state that as the parameters and possibilities of its mixer series are so extensive, they will send the actual operating manual to all interested parties, rather than standard literature.

The operating manual includes an interesting section on the use and application of microphones.

Price: PML422 \$675; PML424 \$675; PML426 \$625.

Accessories: LPS10 power supply (powers up to three mixers) \$65
Rigid carry case \$45

REVOX CORPORATION, 155 MICHAEL DR., SYOSSET, NY 11791.

Circle No. 151

INOVONICS RECORDER ELECTRONICS UNIT HAS "BETTER-THAN-NEW" FEATURES

Model 375 Tape Recording Electronics features full remote control and three-speed equalization. It has a "linearized" recording amplifier and phase-corrected reproduce circuitry for low distortion.



An optional sync reproduce amplifier has independent equalization for optimum performance in both playback modes.

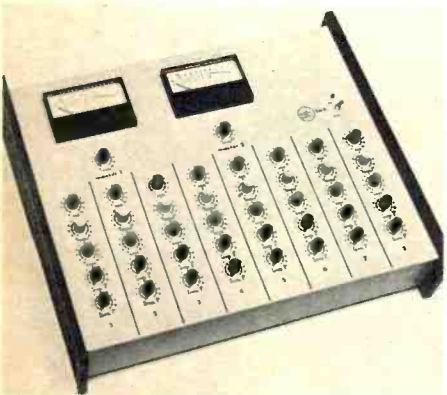
The Model 375 plugs directly into most Ampex recorders and is easily adaptable to most other machines.

The price of the unit is \$690. INOVONICS, INC., 1630 DELL AVE., CAMPBELL, CA 95008, (408) 374-8300.

Circle No. 152

ASHLY MIC MIXER FILLS THE GAP BETWEEN LOW PERFORMANCE UNITS AND STUDIO GEAR

The model SM-8 features an 8 in 2 out configuration with two independent level controls, equalization, and a 30 dB variable pad on each input. Eight direct Lo-Z microphone inputs are provided, along with two Hi-Z line inputs. Forward and monitor signals may be mixed independently, and stereo mixing may be accomplished. Low distortion and noise level (-123dBm equivalent input noise) allows the user to take studio performance into the field.



With a weight of nine pounds and no dimension exceeding 17½", the unit may be used almost anywhere. The rugged

construction is designed to withstand the toughest portable applications.

The SM-8 mixer is priced at \$750.00, F.O.B. Rochester, New York. ASHLY AUDIO, INC., 703 ATLANTIC AVE., ROCHESTER, NY 14609.

Circle No. 153

CBS TECHNOLOGY CENTER ANNOUNCES NEW LINE OF TEST RECORDS

The CBS Technical Series Professional Test Records, for many years the standard for the industry, have recently been revised and reissued. Produced at the recording research laboratory of the CBS Technology Center (the recently-organized successor to the former CBS Laboratories Division), the new line has been expanded to include a total of nine unique recordings.



The new line of records includes the following:

- STR 100 Stereophonic Frequency Test Record
- STR 101 Seven Steps to Better Listening
- STR 112 Square Wave, Tracking & Intermodulation Rest Record
- STR 120 Wide Range Pickup Response Test Record
- STR 130 RIAA Frequency Response Test Record
- STR 140 RIAA Pink Noise Acoustical Test Record
- STR 151 Broadcast Test Record
- STR 170 318 Microsecond Frequency Response Test Record
- STR 1100 SQ Quadraphonic Test Record

The needs of varied users have been anticipated — engineers, quality control specialists, audio display centers, service technicians and audiophiles.

CBS PROFESSIONAL TEST RECORDS, COLUMBIA SPECIAL PRODUCTS, 51 WEST 52nd ST., NEW YORK, NY 10019.

Circle No. 154

HEADPHONE INTERCOM SYSTEM

The Terry Hanley Audio Systems TH-4500 Power Unit is the heart of a powerful headset intercom system. It is intended for use wherever positive communication

ACTIVE EQUALIZERS SERIES 4000

FEATURES

- * 27 Channels on ISO 1/3 octave centers from 40 Hz to 16 kHz
- * 10 dB boost or cut on continuous control
- * Equal Q in both boost and cut
- * Magnetically shielded for low hum pickup
- * Variable low frequency cut
- * No insertion loss
- * All negative feedback for highly linear and stable operation
- * Low noise
- * Dual outputs with plug-in networks for bi-amp option.



Size: 3½" x 17" x 8½" deep

MODEL 4001
Sound Reinforcement Model — Security Cover
Rack Mounting — Transformer Coupled Input

MODEL 4002
Music Reproduction Model — Rubber Feet For Table Use — Phono Type Connectors — Input Level Control

Black Anodized Aluminum Finish

Dealer Inquiries Are Invited

White Call or Write — White Instruments, Inc.
P.O. Box 698, Austin, Texas 78767, Phone 512/892-0752

Circle No. 155

R-e/p 57

THE MOST ACCURATE PROFESSIONAL PICKUP IN THE WORLD!



FOR GUITAR, PIANO, BASS . . . ANY ACOUSTIC INSTRUMENT.

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Circle No. 156

What's Happening in Broadcast Audio



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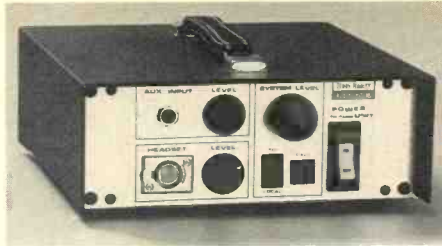
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 Title _____
 Company _____
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between many remote stations is required. The 30 watt power amplifier is immune to short circuits and overloads. Frequency contour and loudness limiting circuits



keep speech clear and understandable. Through the use of light weight Belt Packs, remote stations may be individually connected to a centrally located Power Unit or may be placed where needed on a single line as far as 5,000 feet from the Power Unit. The Power Unit has system level, monitor headset level and auxiliary input level controls. A microphone defeat switch allows the operator to supersede other communication by making the remote units able to talk only when necessary. A flashing call button permits individual stations to signal each other when the microphones have been deactivated. When used with the TH-2400 Headset and Belt Pack this system provides clear and dependable communications under adverse conditions.

TERRY HANLEY AUDIO SYSTEMS,
329 ELM ST., CAMBRIDGE, MA 02139.

Circle No. 157

OVERVOLTAGE PROTECTOR

PLUG-IN OVERVOLTAGE PROTECTOR stops electrical fires, destruction and malfunctioning of electrical/electronic equipment caused by voltage transients, power surges and induced lightning.

Requiring no special tools or wiring, the Transtector ACP-100B plugs into any



standard 110-volt 3-prong outlet. It provides complete protection against hazardous overvoltages arising from power company switching, electrical equipment startup/shutdown, poor regulation and induced lightning.

Utilizing high speed solid-state technology, the ACP-100B offers fully auto-

matic protection. In operation, a multiple stage transient voltage suppressor reacts in 5 nanoseconds to suppress overvoltages. It automatically resets itself after clipping each transient; thereby, permitting continuous, safe operation of the protected equipment.

Should the energy in the overvoltage ever exceed the suppressor's high line, the protector's final stage opens an in-line fail/safe switch. The fail/safe switch opens only under extreme voltage conditions and is resettable.

Size is 3" x 4 1/2" x 3". Price is \$104. Delivery is from stock.

TRANSTECTOR SYSTEMS, 532 MONTEREY PASS ROAD, MONTEREY PARK, CA 91754.

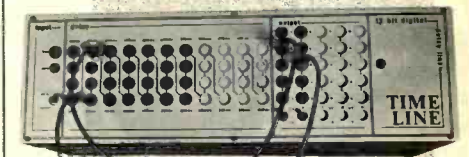
Circle No. 158

BRH90 RADIAL HORN FROM COMMUNITY

Community Light & Sound introduces the BRH90; a 90° fibreglas radial horn that accepts either 2" or 1.4" throat drivers. The horn has a 240Hz flare rate



IT'S ABOUT TIME



TIME LINE is a state of the art digital delay system for the most demanding audio and industrial applications.

Studio Sound's Hugh Ford says "... It works well and has a performance which is likely to be superior to that of the equipment with which it is to be used."

Call or write today for user list and closest dealer.

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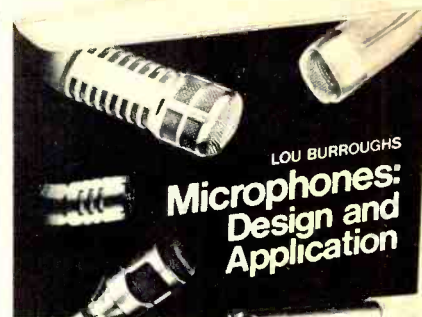
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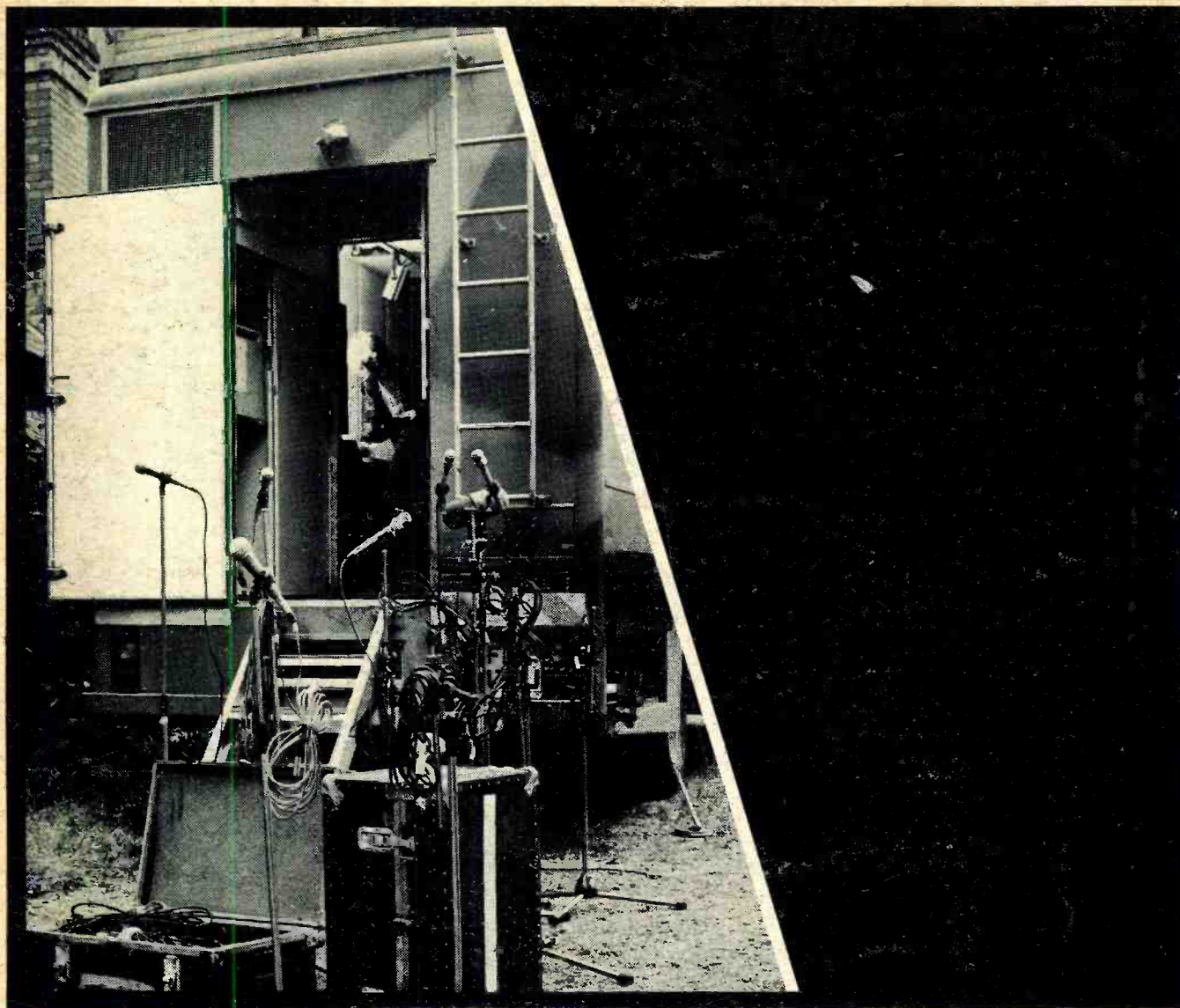
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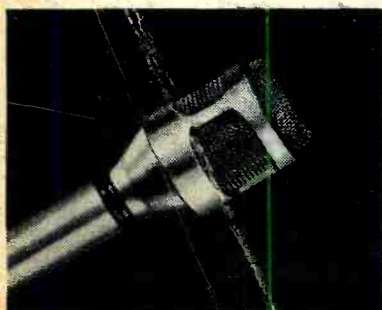
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