THE SOUND ENGINEERING MAGAZINE

NOVEMBER 1980
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db

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Experience the 3rd dimension of sound... Presence.

Record with the Mitsubishi X-80 2-channel digital recorder. Then sit back, close your eyes and listen. You'll swear you're right in there with the players. You'll feel the depth. The presence. The true existence of the sounds you've captured. You'll experience three dimensional sound. No hiss. No print through. No drop-outs. No deterioration through generations.

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These days, most people agree that digital is the recording technology of the future. Unfortunately they're also under the impression that it won't be available until then.

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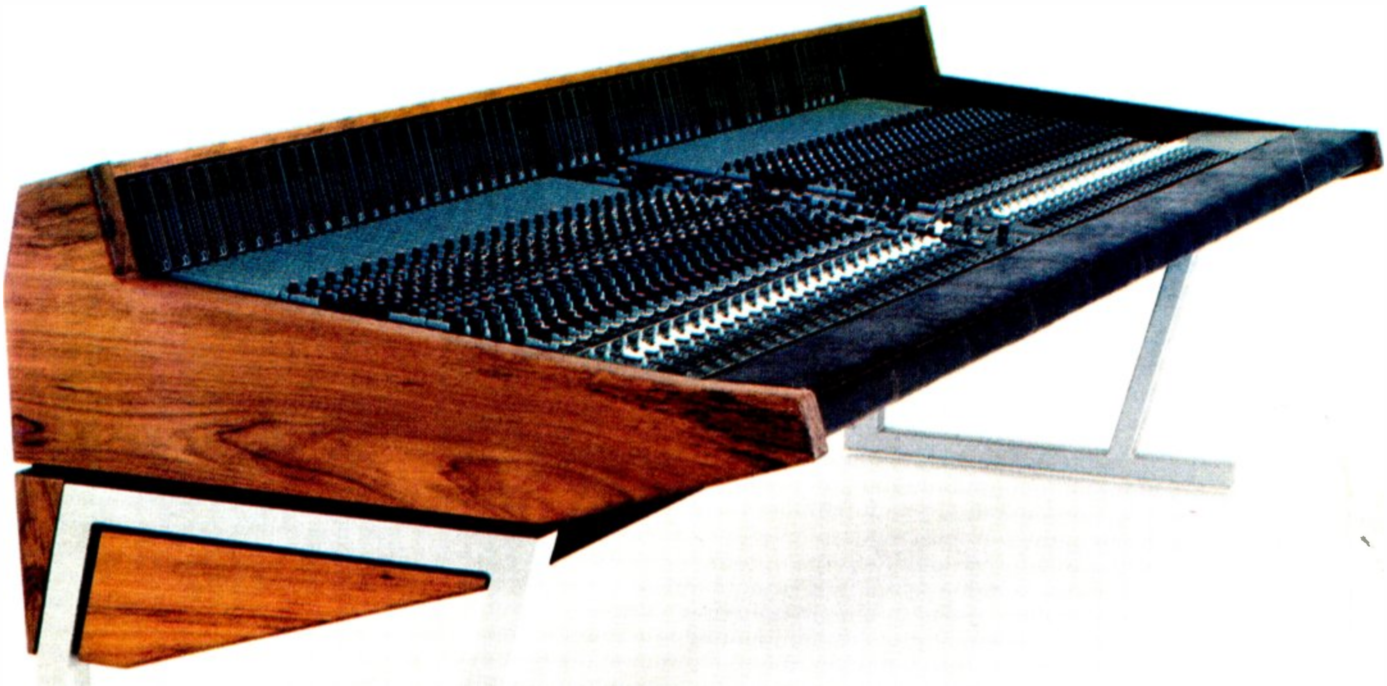

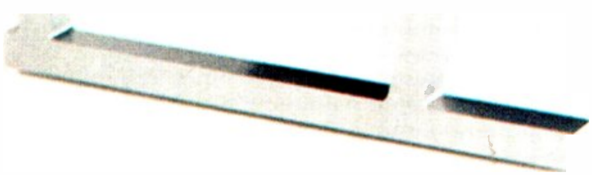

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COMING NEXT MONTH

• In December we will have a double-barrelled issue. Main theme will be the recording studio with three articles specially devoted to this topic.

Don Davis has written a paper that describes the methods and advantages of Acousta-Voicing Studio Monitors.

New Concepts in Studio Equipment Design by R. N. Andrews details devices developed to make the lot of the recording engineer at RCA easier.

A picture/text interview with John Eargle, chief engineer of Mercury Records gives the reasons why an Audio Designs' multi-channel console has been added as the main control unit for Mercury in New York. Included will be a series of photos that show the tribulations of placing a giant pre-built console high in a modern office building.

The Teldec video disc has burst like a bombshell on the audio/visual-home entertainment scene. We have commissioned columnists Arnold Schwartz and Martin Dickstein to take detailed looks at the system in their respective columns. In addition, writer Edward Tatnall Canby discourses on the implications of this exciting development to the professional audio community.

And there will be our regular other columnists: George Alexandrovich, Norman H. Crowhurst, and John Woram. Coming in **db**, The Sound Engineering Magazine.

ABOUT THE COVER

• This view along a tape-duplicating facility has been created from an original photograph kindly supplied by GRT Corporation. It's all by way of telling you that this issue's special theme is Tape Duplication and the story begins on pg. 26.

db

THE SOUND ENGINEERING MAGAZINE

NOVEMBER 1970

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a note from the publisher

Many of our readers with a keen eye for graphics will note that this issue contains a number of changes. Our Art Director, Bob Laurie, has completely redesigned the cover format with an eye to a contemporary, exciting presentation that is in keeping with the feel and flow of the audio world. We hope you like this design concept and the ones that follow.

Internally we have made other changes in headlines, type faces and other details which bring an overall improvement to our general appearance.

We hope that our readers find these purely mechanical changes make their reading of **db** more pleasant and enjoyable.

Due to a sudden and completely unforeseen wildcat strike at our printers, our October issue was delayed about two weeks before reaching the Post Office. This unavoidable delay is most regrettable and we have made strenuous efforts to get back on schedule with alternate sources of printing. We now have this under control and henceforth should maintain our regular schedule—and with some luck improve upon it.

Robert Bach, *publisher*

advertisers index

letters

A number of correspondents have had difficulty in locating the integrated circuit mentioned in Walter Jung's September article, An IC Line Amplifier. Mr. Jung writes:

The manufacturers and their respective part numbers (for the TO-5 style, industrial temperature range unit) are as follows:

U5R7723393 (uA723C)	Fairchild
S5723L	Signetics
SG723CT	Silicon General
VA5R72339 (VA723C)	Varadyne
RC723Q	Raytheon

Check your local distributors for stock on the above. If not available locally, you will surely be able to obtain units through one of the large national industrial distributors. You may have to ask for the 723 *regulator*, however.

Walter G. Jung
Rockville, Maryland

---

you write it

Many readers do not realize that they can also be writers for **db.** We are always seeking good, meaningful articles of any length. The subject matter can cover almost anything of interest and value to audio professionals.

Are you doing something original or unusual in your work? Your fellow audio pros might want to know about it. (It's easy to tell your story in **db.**)

You don't have to be an experienced writer to be published. But you do need the ability to express your idea fully, with adequate detail and information. Our editors will polish the story for you. We suggest you first submit an outline so that we can work with you in the development of the article.

You also don't have to be an artist, we'll re-do all drawings. This means we do need sufficient detail in your rough drawing or schematic so that our artists will understand what you want.

It can be prestigious to be published and it can be profitable too. All articles accepted for publication are purchased. You won't retire on our scale, but it can make a nice extra sum for that special occasion.

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George Alexandrovich

THE AUDIO ENGINEERS HANDBOOK

• The advent of solid-state technology radically changed the thinking of circuit designers. Amplifiers shrank to the size of a match book with performance exceeding that of their vacuum-tube counterparts. Circuits and design approaches changed accordingly. Appearance on the scene of the operational amplifier with its extremely high input impedance and low output impedance all but made obsolete impedance matching between amplifier stages. Contrary to classical textbook examples which use transformers almost everywhere, today's circuits are especially thought of to eliminate as much iron as possible. After all, transformers and impedance matching don't lend to microminiaturization techniques in manufacturing circuit assemblies. It is simpler to put hundreds of transistors on a single chip than to reduce the transformer to half size and maintain its performance. Besides transformers continue to rise in cost while integrated circuits cost less and less.

The subject of using transformers was brought up because textbook mixing networks (and many in actual use) are designed to transfer maximum power by matching impedances. However, modern operating techniques of sound mixing demand mixing-network performance that is not possible using matching techniques. As an example: in multi-track recording you may want to split signal between two channels

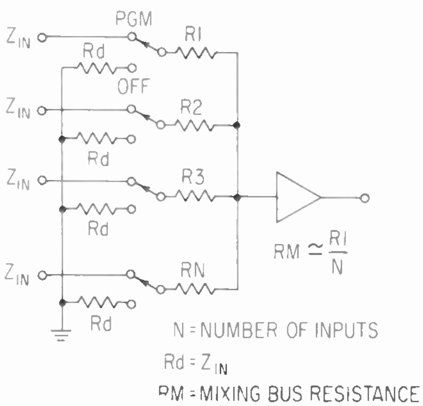


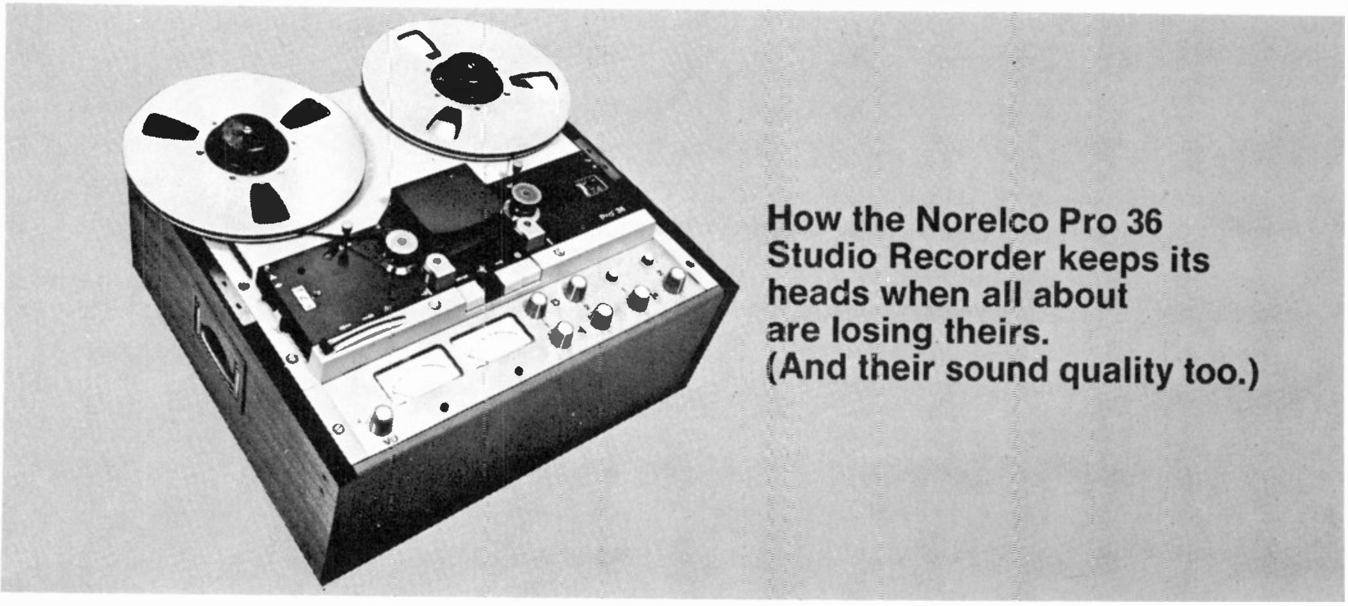
Figure 1. A conventional mixing circuit.

without increasing crosstalk between them. In matching the circuits you will experience level loss due to division of available power. This is a serious drawback with modern mixing techniques. It is not uncommon to find systems where more than twenty mics are being used, and with capabilities to handle many more. This means that the mixing network should be capable of combining some thirty inputs. Thirty sources mean insertion loss of the mixing network of 29.7 dB. If one is lucky enough to have zero level feeding his mixing network then the output of the mixer is high enough not to worry about noise. But most of the time output of the mic preamp which is zero is reduced to -15 or -20 dB level by the mic fader. This signal is then fed into the mixer. Now your level is -50 dB. Add a few inputs and slightly lower the gain with the fader and you have a noise problem. It's not that noise will start bothering you, but your mixing network booster amp will be the limiting factor in generation of noise.

Before we get to methods of correcting this condition I should remind you that, whether you use 600-ohm mixing resistors in the network or 1 megohn, the insertion loss is the same—only combined impedance of the mix changes. For example ten 600-ohm resistors will produce a bus resistance of 60 ohms while 10 k ohm resistors will produce 1000 ohms. The difference between these two values is that you can connect several 10 k resistors to the same source to feed several mixing networks while it would be impossible to do this with 600-ohm mixing resistors.

In order to eliminate any possibility of the mixing network worsening our s/n figure, we must find a way to prevent signals from dropping too low. Our first reaction might be to put a booster amp after each input fader, so as to feed zero level into the mixing network. This is fine, but for thirty inputs it means thirty booster amps. Why not split the

Announcing the recorder with 10 times normal head life.



Conventional recording and playback heads wear out within a couple of thousand hours of use. But long before then, their electrical characteristics change . . . so your sound changes too. With the Pro 36 studio tape recorder, these problems are non-existent.

Reason: Norelco's exclusive glass-bonded Ferroxcube heads. Made of material almost diamond-hard, they take 10 times the wear of conventional heads. But that's not all. The unique glass-bonded construction maintains precise gap width and electrical characteristics in spite of wear. Amplifier adjustments are virtually never needed. And precision head mounting also makes azimuth adjustment a thing of the past.

The rest of the Pro 36 lives up to the heads. It's the only professional tape recorder with 3 speeds. You get 15, 7½ and 3¾ IPS. Electronically switchable.

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Other features: total remote control, push-button semiconductor switching, NAB and CCIR equalization, provision for fourth head, controlled tape lifters, horizontal or vertical operation, and much more.

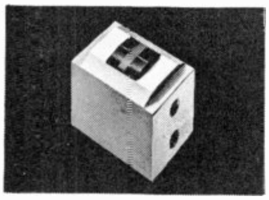
Every broadcast studio, production studio, and sound studio deserves the tape recorder that keeps its head...so you won't lose yours. The Pro 36! Contact Norelco for all the technical data now.

PERFORMANCE SPECIFICATIONS

Wow and Flutter:
weighted peak value at 15 in/s: max. 0.04%

Overall Frequency Response (NAB Specs):
at 15 in/s: 30 . . . 15,000 Hz ±2 dB
at 7½ in/s: 30 . . . 15,000 Hz ±2 dB
at 3¾ in/s: 50 . . . 10,000 Hz±2 dB

Signal-to-Noise Ratio: NAB unweighted (reference standard operating level)
62 dB at 15 in/s
60 dB at 7½ in/s
56 dB at 3¾ in/s



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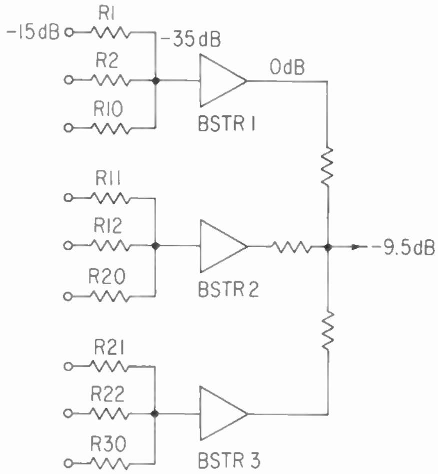

Figure 2. This is the method for the reduction of mixing losses.

mixing network into groups of ten inputs. Each group will now have its own booster amp which feeds into a combined mix of three boosters. Each booster—with a gain of 35 dB—will bring the level to 0 dB, then in mixing it with other two levels loss will only be 9.5 dB. This level is just high enough to feed into the submaster fader where another 15 dB loss is generated. Output of the fader (submaster) is now -24.5 dB just right for the line amp (or program amp). See *Figure 2*.

When you mix so many signals from so many sources into one channel, crosstalk between channels is of no consequence. All signals meet anyway in the same bus. But what if you have to split signal between the two channels while maintaining interchannel leakage down to -60 or -70 dB. In matching networks crosstalk is at -26 dB below the level of the source (for ten inputs) and 36 dB for thirty inputs. There are basically two ways of solving this problem without using an isolation amplifier for each split feed.

One way is to apply active mixing using a summing amplifier. This device, available as an i.c., is adjusted for unity gain by applying heavy negative feedback. Input impedance (apparent source resistance) is very low. As seen from *Figure 3*, connections to the input are made in the conventional way—with one exception: when switching out any or all inputs, dummy load resistors are not needed to keep the impedance of the bus constant (such as in *Figure 1*) because amplifier input impedance is usually much lower than bus impedance.

As the number of inputs increases, mixing resistors have to be made larger than shown, if amplifier input resistance is fairly high, otherwise good crosstalk figure will not be realized. If mixing resistors are 10 k each and the op amp input is 100 ohms then crosstalk is about 60 dB regardless of the impedance of the sources. Making the mixing resistors larger would affect mixing losses of the network. One has to strike a happy medium for optimum operation of the circuit.

There is also another way to achieve low crosstalk—a bridging mixing network. This circuit resembles conventional mixing network but uses a fairly large value of mixing resistors. It could be used only in systems that are physically compact and properly laid out, with levels feeding a mixing network of not lower than -10 dB. Although this network produces mixing loss typical to a conventional network, it offers cross-talk levels exceeding 80 dB regardless of the impedance of the source or mixing amplifier input. The only requirement is that any inputs disconnected from the source should be grounded. Because mixing resistors are usually in the 100 k ohm range, and whether they are connected to a source with resistance of 0 or 600 ohms or not, (only 0.5 per cent of the total resistance) does not change the impedance of the mixing bus. All inputs in this mixing network are truly bridging their respective sources, so even if as many as twenty channels are fed from one source, combined loading on this circuit is only 5 k ohms. Again, loss of this network depends on the number of inputs the circuit is designed for. But the most importank aspect of this combining network is the ability to offer channel

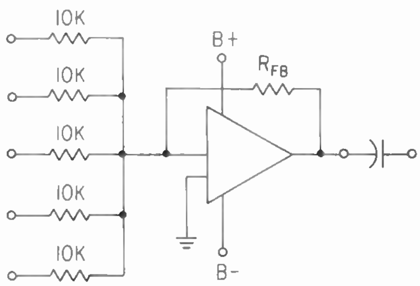

Figure 3. A block diagram of an op amp mixer.

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Unless you're using the best in tape, you can expect a lot of sour notes among the sweet.

One way to tell which is best is to look at the guarantee. The best goes the limit. Ours is guaranteed, unconditionally. Maxell tapes must perform to your standards or we'll replace them, pronto, with no questions asked.

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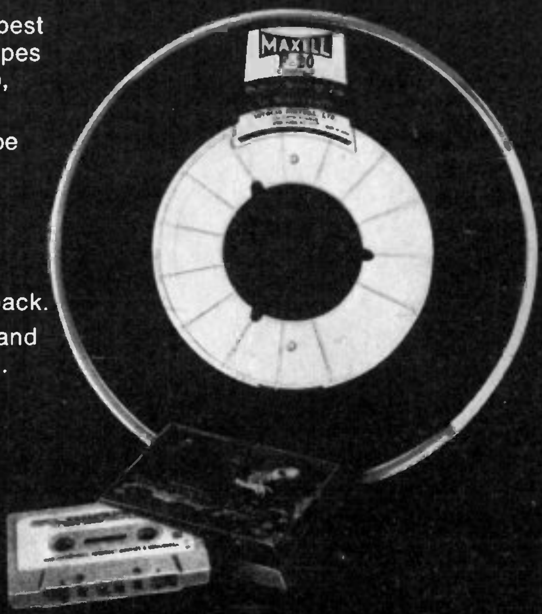

- For general recording purposes, Maxell bulk tapes for C-60, C-90 and C-120 cassettes.

For details on all Maxell professional tapes, write

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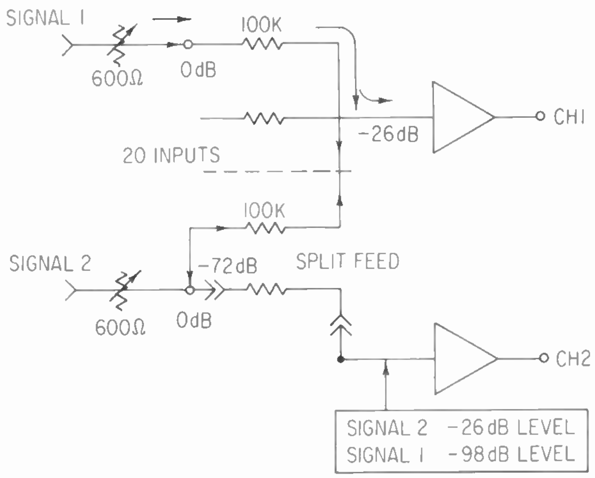

Figure 4. The crosstalk between channels.

isolation. Let's see what it takes for signal from one channel to reach another.

Let us say that a source of 600 ohms feeds a mixing resistor of 100 k (See *Figure 4*). The mixer is designed for twenty inputs. Level of the mixing bus is at -26 dB. In order to reach another channel, signal has to travel through the mixing resistor, forming a voltage divider with the source impedance feeding the second channel. Since this path offers a loss of 46 dB, combined crosstalk is at -72 dB. If we were to assume that source impedance may be lower than 600 ohms when using (for example) an amplifier with output impedance of 10 ohms, then crosstalk would be 86 dB.

True value of a mixing network offering little or no crosstalk shows in the monitoring circuits, where it is desirable to have a mix of all channels at once. Communication circuits found in multipath mixers benefit greatly from bridging mix nets.

In contrast to what has been discussed is the subject of broadcast production consoles. The time has come when designers of boards have to take a hard look at the techniques used in mixing. Most stock consoles cannot accept more than one channel without changing the impedance of the mixing bus, thus affecting the level at the same time. This was acceptable for many years when production techniques did not require anything more elaborate. But for the cost of a few resistors and attendant assembly time, the same boards can double up as recording and production consoles, thus saving money. How many boards are there that don't use any mixing resistors? If someone decides to use modern transistorized amplifiers with the same circuit he is in for a surprise. The first time he will switch in two channels, signals from both channels will be shorted out, because of the low output impedance of the amplifiers.

It is my feeling that within a few years we will be working with boards using not only the latest solid-state devices but that new trends in active summing of signals will develop into equally new technology, perhaps using multiple stages of mixing and amplification and isolation—so to be able to mix any number of circuits with no degradation of signal or increase in noise. ■

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Headache? Take aspirin.

Tape tension trouble? Take TEAC.

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This tape deck can't cure everything that ails you, but you're bound to feel better once you own one.

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ARNOLD SCHWARTZ

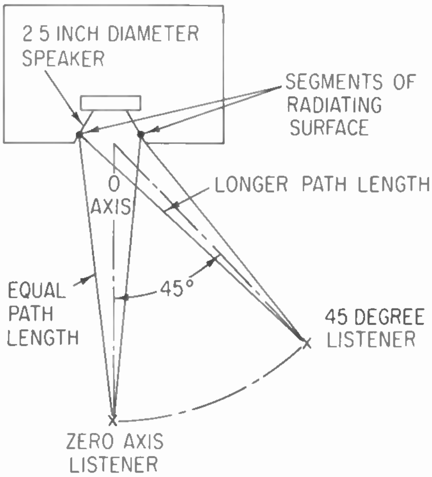
THE FEEDBACK LOOP

• Recent trends in speaker system design have indicated an increasing awareness of the problem of directional characteristics. Virtually all realistic speaker response curves published are on-axis, anechoic measurements. The prospective buyer in the high-fidelity show room usually stands directly in front of, and quite close to the speaker he is evaluating. This position enables him to hear the on-axis response, and the closer he gets to the speaker the more he tends to eliminate room characteristics from consideration. When the speaker system is in use at its ultimate location, whether in the studio, listening room, or at home, directional characteristics have a profound effect on sound quality.

DIRECTIONAL CHARACTERISTICS

Directional characteristics deal with the radiation of the higher frequencies as a function of angle. These characteristics are also referred to as the high-frequency dispersion characteristic. We can demonstrate directional characteristics by considering the action of a speaker mounted in an infinite baffle. In practice, in the high-frequency range that we are considering, a closed box is a close enough approximation to an infinite baffle. *Figure 1* shows a speaker with an effective radiating surface of 2.5 inches diameter mounted in a closed box. The zero axis is the center line perpendicular to the plane of the baffle upon which the speaker is mounted.

Figure 1. Path length difference and speaker directional characteristics.



ON AXIS

We will now observe the effect of two symmetrically placed segments of the speaker's radiating surface on a listener situated on the zero axis (on axis). The acoustical energy from each segment will travel the same distance to the listener and arrives there in phase (see *Figure 1*). The energy from each segment will then add directly. This in phase condition will hold true for all frequencies.

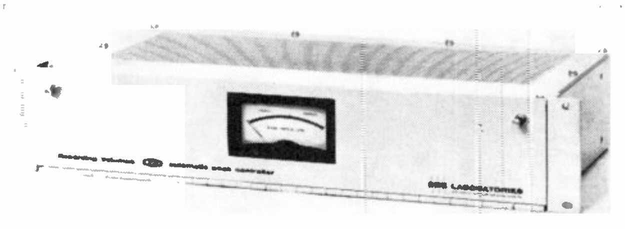
OFF AXIS

We now locate the listener the same distance from the speaker but at an angle of 45 degrees off the zero axis (see *Figure 1*). The acoustical energy from the left hand segment arrives slightly later than the energy from the right hand segment due to the longer path length of the former. This delay corresponds to a phase shift of approximately 147 degrees when we drive the speaker at a frequency of 4,400 Hz. Now when the energy combines the total acoustical power will be -11 dB down relative to the power found on the zero axis. By integrating the effect of all the segments comprising the total area of the speaker diaphragm we would be able to find the acoustical output at 45 degrees relative to the zero axis. Of course, the simple and direct way of measuring output is to use a microphone. *Figure 2* shows the 45 and 60 degree outputs (as a function of frequency) of the speaker relative to the zero axis output. We can see the high frequency attenuation at these angles, amounting to -5 dB at 10 kHz, and -11 dB at 60 degrees at the same frequency.

POLAR RESPONSE

Directional characteristics are usually displayed in the form of polar response. In this type of display we select a single frequency and plot the relative output as a function of angle (see *Figure 3*). The polar response provides a "picture" of the speaker radiation pattern. As fre-

How to record on a higher level!



With automatic peak control

The CBS Laboratories' Recording Volumax Model 420 automatic peak controller for recording:

- permits higher recording levels without overloading.
- eliminates the distortion of clippers and the thumping and pumping of conventional limiters.
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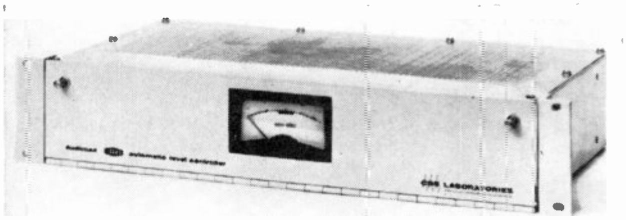
The completely solid-state Model 420 Recording Volumax is unconditionally guaranteed.

- Stereo model also available.



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Unconditionally guaranteed to outperform ordinary compressors, or AGCs, the solid-state Audimax III offers the ultimate in automatic level control for recording engineers.

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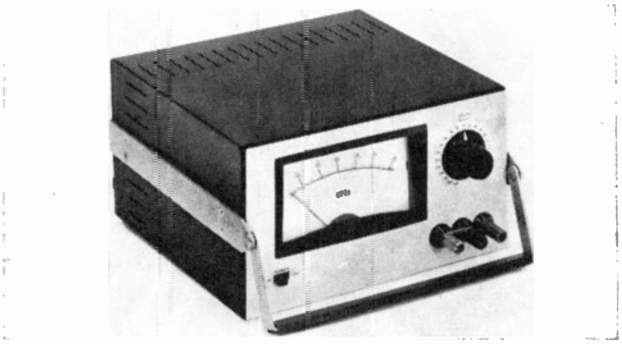
A special **Return-to-Zero** feature returns gain to normal during standby conditions. In short, the Audimax reacts to any gain situation in exactly the same manner as an engineer. Price: $625. Stereo model also available — $1,250.



With the world's first 60 dB-wide linear scale meter

The Model 600 Wide Range Program Monitor is the first monitor to combine the latest developments in audio technology with the reliability of solid-state design for accurate audio measurement and analysis on a **single** 60 dB-wide scale.

Where the standard Volume Indicator measures only the top 23 dB of signal level logarithmically, this new Program Monitor displays information from +3 to −57 dB on a single **linear,** decibel scale, thus permitting accurate reading of low level audio material as well as line noise during program pauses. The 0 dB reference settings are adjustable from +18 to −22 dBm.

The 600 is also equipped with a separate DC output for graphic logging over the full 60 dB range or to drive a second meter for remote monitoring.

While not intended as a replacement for the standard Volume Indicator, the 600's meter ballistics are such that its readings are compatible with VU indications. It's a practical program monitor as well as a valuable measuring tool.

It is also available in a standard 19-inch mounting rack from which it can be easily removed for portable use. Price: $505. Rack mounted: $550.

FOR FURTHER INFORMATION, WRITE:

PROFESSIONAL PRODUCTS

CBS LABORATORIES

A Division of Columbia Broadcasting System, Inc. 227 High Ridge Road, Stamford, Connecticut 06905

Circle 22 on Reader Service Card

quency increases the pattern becomes progressively narrower for our 2.5 inch diameter speaker.

In the typical speaker system the high-frequency radiation is assigned to a small speaker which has, among other advantages, a broader radiation pattern at high frequencies than larger diameter speakers. Nevertheless, even relatively small speakers have polar patterns that become narrow at high frequencies because of the phase shift due to path length difference. It should be noted that when more than one tweeter is mounted in the same plane, a common practice with some manufacturers, the polar response becomes even narrower than it would otherwise.

DIRECTIONAL CHARACTERISTICS AND THE LISTENER

How does the narrowing of the radiation pattern affect the listener? When he is located very close to the speaker, as is the case of an engineer at a console where the monitor speakers are within a few feet directly in front, he is in the *near field*. He hears mainly the directly radiated sound. Energy that is reflected off the walls and other surfaces is only of secondary importance. Now, if the speakers are directed towards the listener he will hear the zero-axis response, and will not notice any losses due to deficiencies in the polar response. If the listener moves off the zero axis he will notice a change. Since woofer and mid-range speakers, by virtue of their size in relation to their operating range, usually have broader polar characteristics he will not notice any change in the low and mid frequencies. High frequencies, however, will be attenuated due to the relatively narrow polar patterns.

When the listener is located at some distance from the speaker, as might happen in a studio listening room or at home, he is in the *far field*. Regardless of his position with respect to the zero axis, what he hears will be determined mainly by the total polar output of the speaker system. The room characteristics will average out the total energy radiated at each frequency, and what the listener hears may be at some variance from the near field-zero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The Sony ECM-377 and the Sony C-500 are available at select Sony/Superscope dealers. For their names, as well as complete details and specifications, please write Special Application Products Division, Sony/Superscope, 8207 Vineland Ave., Sun Valley, Calif. 91352.
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World Radio History

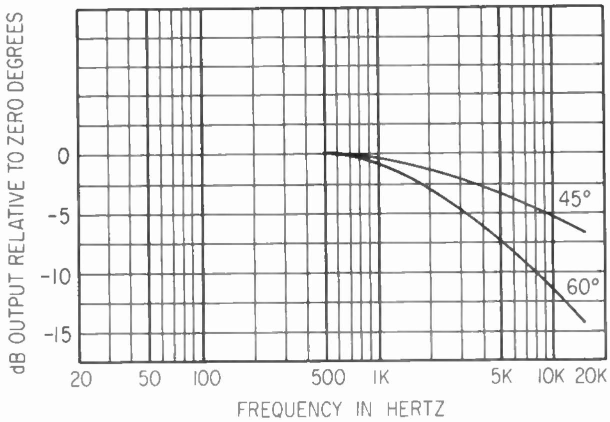


Figure 2. The response of a 2 1/2-inch speaker at 45 and 60 degrees relative to zero degree output.

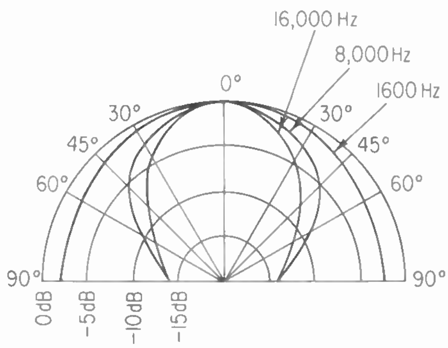
axis response. Once again the narrower polar pattern of the high-frequency speaker, as compared to the broader patterns of the low and mid range speakers, will cause an over-all loss of high frequencies.

The distance from the speaker to where the reverberant field predominates over the direct radiation depends upon the dimensions and other acoustical properties of the room. Use of room equalization now current is more closely related to compensating for irregularities in total power output of the speaker at various frequencies than to the room response.

Speaker system designers use different approaches to overcome the narrow polar patterns at high frequencies. Included in these approaches are tweeter design, tweeter mounting in more than one plane, use of reflected sound to disperse high frequencies, and acoustical networks. A somewhat different approach to the problem involves the use of auxiliary high-frequency speaker systems which have broad or omni-directional patterns. They utilize a number of high-frequency speakers mounted in different planes so that the polar responses are combined to provide an omni-directional radiator.

To the critical listener, whether he is evaluating a recording in the studio, or at home, speaker directional characteristics can have significant effect on sound quality. ■

Figure 3. The polar response of a 2 1/2-inch diameter speaker.



John M. Woram

THE SYNC TRACK

• In the last month's column, *Figure 6(B)* showed that, as the program level feeding a limiter decreases, the system gain increases. Since low-level program is accompanied by tape hiss, the listener may be distracted by the sudden increase in hiss as the system gain rapidly rises during the quieter passages of music.

Obviously, the less hiss, the less of this type of distraction—which is just one more argument for a noise reduction method such as the Dolby system. With a Dolby'd tape, sudden changes in system gain will not be quite so distracting. Another Dolby dividend is that you probably won't need as much limiting in the first place, since the quieter passages are now more audible, due to the lower noise level.

Although the Dolby system is a great tool, it does not make musical decisions, and if the musical content suffers because of sudden gain increases, other steps must be taken. For one thing, a longer release time may be selected on the limiter. (Unless otherwise noted, all references to limiting, or limiters, apply equally to compression and *vice versa.*) Release time is generally defined as the interval required for the system to return to constant gain (on many commercial units—to about 2/3 recovery) once limiting ceases. The longer the release time, the more gradual (and therefore less apparent) the gain increase. A disadvantage of a longer release time is that when an occasional short percussive sound causes limiting, the system will take a relatively long time to recover when the percussive sound ceases. In selecting a release time, the musical, and hiss, content must both be considered to determine the proper setting.

EXPANSION

Some units have a so-called expansion feature in addition to limiting and compression. Expansion might be defined as a compression ratio of less than 1, such as shown in *Figure 1*. In the expansion mode, the dynamic range of the output is larger than that of the input—just the opposite of compression. As a complement to limiting, expansion may restore some sense of dynamic range to the program. However, care must be taken so that expansion does not begin below the residual hiss level. As input level increases, expansion ceases, and limiting begins.

To digress a little further into hiss, Allison Research demonstrated their KEPEX system at the recent Audio Engineering Society Convention in New York City. Among other things, it seems the KEPEX may be set up as a gating device. Once a signal falls below a predetermined level, the KEPEX shuts that microphone or track off, thereby eliminating extraneous low-level noise in the case of a mic, or hiss on a finished tape. This feature might be considered as a possible complement to fast release times on a limiter. Once the program level falls below a pre-set level, the KEPEX should turn the system off, thereby preventing the limiter from raising the hiss

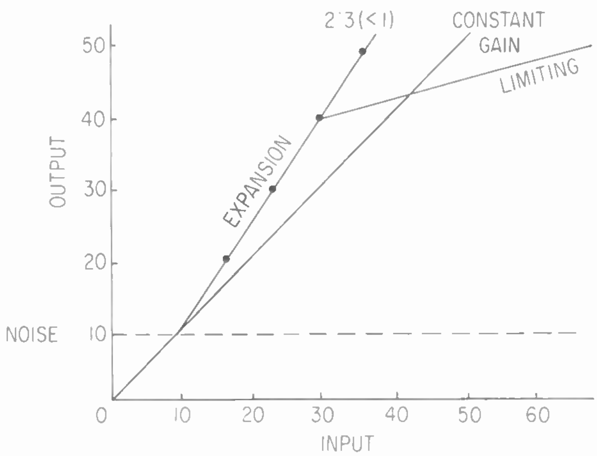


Figure 1. Expansion can be defined as a compression ratio of less than 1.

Neve

SOUND CONTROL EQUIPMENT

One of the recent examples of Neve craftsmanship designed and built to the requirements of Cine TI Studios Ltd., London.

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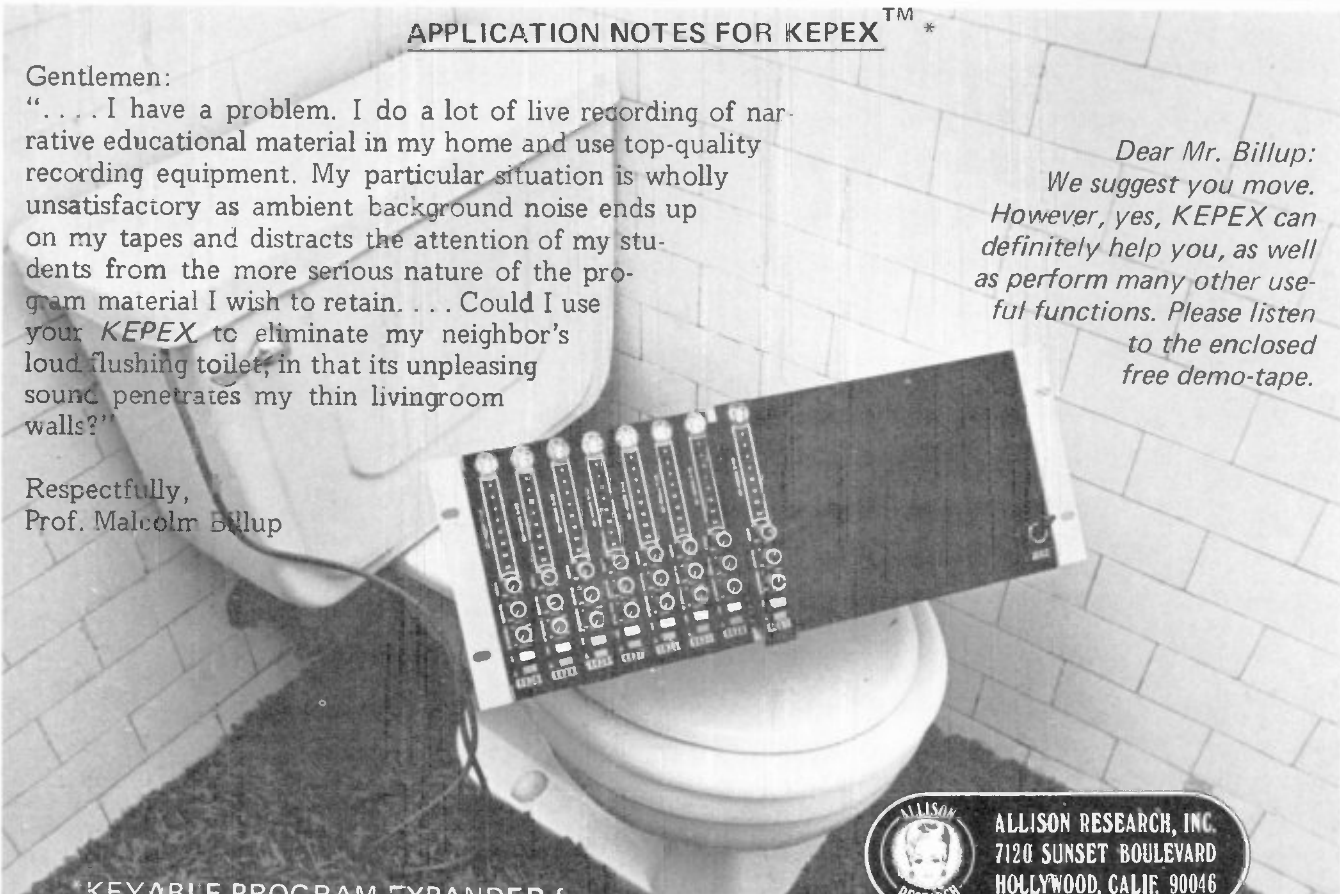

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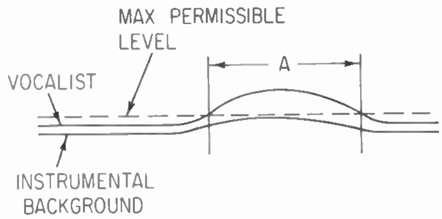


Figure 2. One problem in tape mastering is keeping the vocalist in proper perspective to the instrumental background.

level. (The KEPEX seems to have a multitude of other applications too, which I'll try to uncover for a future column.)

SELECTING A LIMITER/COMPRESSOR

Readers in the market for a limiter or compressor are referred to the guide published in last month's issue on pages 33-35. Remember that compression ratios must be referred to their various thresholds before they can be compared to each other. On a more practical note, find out if the controls you will be using are conveniently located. Some units have one or more controls on the *back*. If these controls are important in your application, you're going to be in big trouble if you rack mount the units.

Most of the newer limiter/compressors have a stereo interconnection, which is important in tape-to-disc work, as well as in tape copying, etc. This provision allows two limiters to be coupled together so that when one track of a stereo tape requires limiting, the other track is limited by the same amount. Without this feature, a sudden limiting action on one track would cause an apparent shift in sound towards the other track if its level remained unaffected.

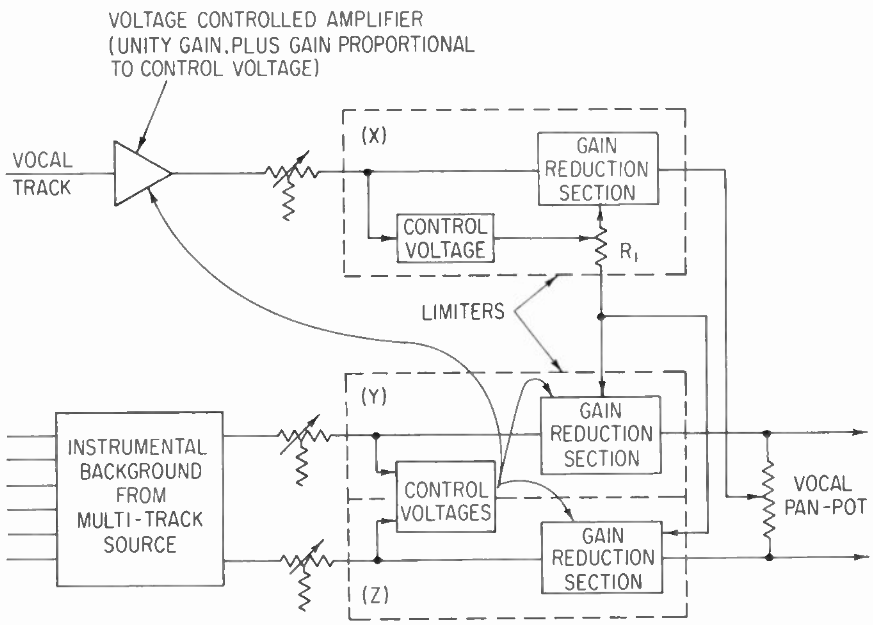
One recurrent problem in tape mastering is keeping the vocalist in proper perspective to the instrumental background. Consider the typical situation pictured in *Figure 2*. Levels have been adjusted so that the vocalist remains somewhat above the instrumental background. At certain times however, the singer rises still further above the background, and the maximum safe level is exceeded, as at (A) in *Figure 2*. Now if the vocal track only is limited, it may become buried in the background at these points. Yet it may not be musically desirable to limit the entire program by x dB.

An arrangement such as shown in *Figure 3* may be possible, if three limiters are available. One of them (X) is inserted in the vocal track; the other two (Y) and (Z) are stereo interconnected and inserted in the mixed-down background tracks. The control voltage from limiter (X) is brought out to potentiometer R^1. Varying R^1 will cause different amounts of limiting at the vocal limiter and the stereo pair. For example, a voltage that will cause 6 dB of gain reduction at (X) will only reduce (Y) and (Z) by 3, dB, and so on.

Note that the control voltages from the stereo pair regulate a voltage controlled *amplifier* in the vocal track, as well as their own gain reduction sections. With proper regulation, an increase in instrumental level will cause gain reduction in the stereo pair, and amplification in the vocal track. Yet, if the vocal track approaches maximum permissible level, the vocal/instrumental combination is reduced according to the R^1 setting.

Experimenters are warned that I have not yet tested this set-up, since it is a little on the involved side.

Figure 3. This arrangement, using three limiters can solve the problem brought up in Figure 2 and the text.



NEW DEVELOPMENTS

In a recent AES paper [1] a limiter is described that features a delay line in the signal chain. By delaying the program (imperceptibly, about 150 microseconds) the limiter has time to react and cause gain reduction before the arrival of the signal at the gain-reduction section. It is claimed that this innovation eliminates the distortion problems associated with limiters having some finite attack time.

And in a Philips technical bulletin describing the PYE 5752 limiter, another unique control system is described. Grossly oversimplifying their description, the unit features a high-speed switching (on-off) device operating on the duty-ratio principal. The greater the off-time, the more energy is removed from the original signal. Further processing removes the switching pulses, leaving an attenuated output that possesses the same wave shape as the input.

These are but two new approaches to creating the definitive limiter/compressor. In the future, I hope to be able to discuss the recent progress in automation (once I figure it out—don't wait up). Some of this progress utilizes advanced limiting concepts—some of it minimizes the need for extensive limiting. In any case, it should go a long way toward reducing some of the problems that have so far attended wide dynamic range programs.

REFERENCES

[1] *A Wide Dynamic Range Limiter and Program Conditioner:* David E. Blackmer (consultant) and Saul A. Walker, Automated Processes, Inc. AES Preprint Number 757 (M-4).

[2] *Sound Sense—PYE 5752:* Philips Broadcast Equipment Corp., One Philips Parkway, Montvale, New Jersey 07645.

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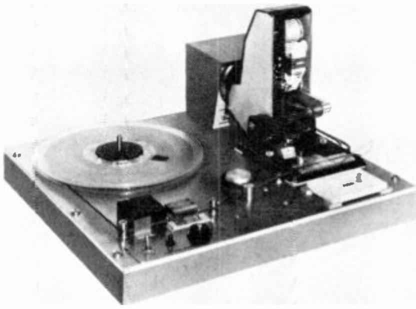
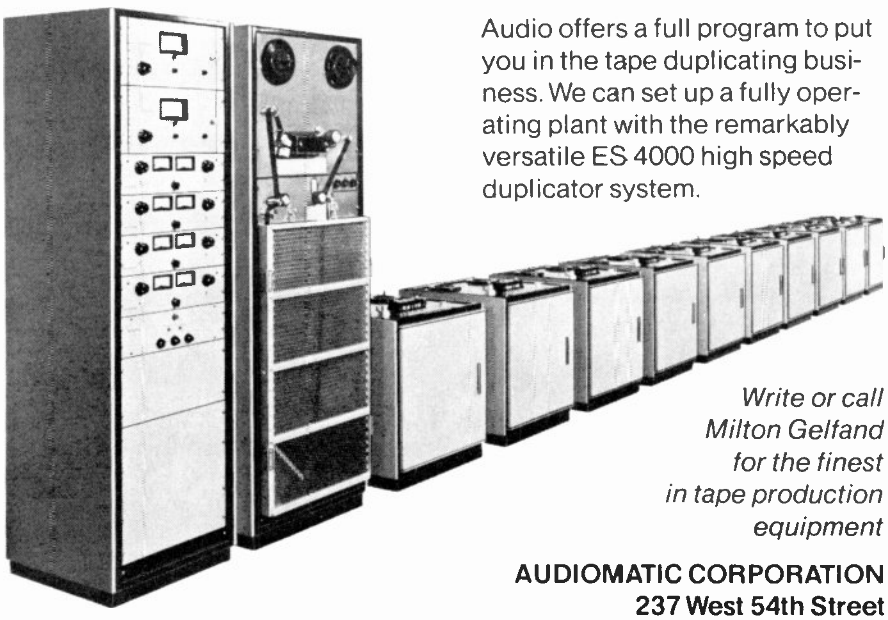


The Model 200 automatic tape splicer (shown here mounted on the winder for cassette operation) is tops in popularity because, at modest cost, it greatly increases production and makes uniform, perfect splices.



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NORMAN H. CROWHURST

THEORY AND PRACTICE

• Input matching, particularly of microphones or pickups to amplifiers, has been discussed before, if not in this column. From the professional viewpoint, where each component is viewed as an entity, the matter is usually confined to that of selecting ideal impedances, or at least ones that match—or correspond.

Thus, from this viewpoint, a line-impedance microphone needs an amplifier with a line-impedance input, and enough gain for microphone, rather than merely the correct impedance, which could be intended to accept a telephone line level as input. A high-impedance microphone must be connected to a high-impedance microphone amplifier input, and a low-impedance mic to a corresponding low-impedance input.

That is a simple matter of matching—by numbers—that does not require any knowledge of the circuits involved inside the microphone or amplifier, to achieve the desired end. Here we plan to discuss the "inside" details a little more. There is also the question of ideal impedance for various purposes, including the method of connection used with each, such as concentric cable, shielded twin, etc.

Back in the days of tube amplifiers, the input that mattered to the tube amplifier was voltage input to the grid. A high impedance microphone or pickup would be connected directly between grid and ground, using a single shielded (concentric) input cable (*Figure 1*). Any other impedance would yield lower voltage output for a unit of the same power-conversion efficiency. So to achieve maximum gain, as well as the best possible signal-to-noise ratio from the tube, an input transformer was used to step the impedance up to a high value to suit the grid.

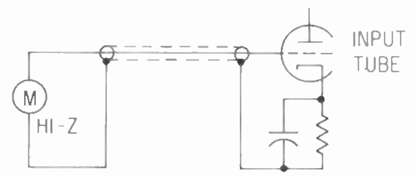


Figure 1. The old tube circuit provided a voltage input to drive the grid.

The advent of transistors changed this. The important input is no longer signal voltage, unless the transistor is of the field-effect type. In the latter case, the situation is not unlike that discussed for tubes.

But the other, ordinary type transistor essentially amplifies current. True, operated grounded base, it can be considered a voltage amplifier, at constant current, but this is still different from the tube or fet situation, in which the impedance presented by the input is high: the emitter-to-base impedance of a transistor is quite low.

However, most transistor circuits use the base as input, not the emitter, for a variety of reasons, not the least of which is a supply problem for grounded base: emitter and collector need supplies of opposite polarity. Using base as input can have either the emitter or collector essentially grounded, with the other as the output electrode of the input stage.

Grounded collector (*Figure 2*) provides zero voltage amplification (with apologies to those persons who tell us that various standards do not acknowledge the term *voltage amplification*—how else would you say that?), but amplifies current, thus changing impedance as well as providing gain. This is the emitter-follower circuit, analogous to the old cathode follower of tube days.

There are differences from, as well as similarities to, this older circuit, that we have discussed before. The main one is the fact that the impedance connected in the emitter output from the stage is presented at the base input, multiplied by the current gain of the stage.

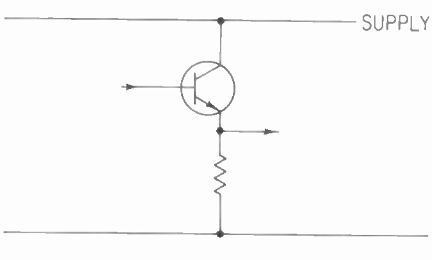


Figure 2. A transistor circuit using grounded, or common collector, provides only current gain, like the cathode follower of tube circuits.

Thus, if the emitter-connected impedance is 1,000 ohms, the base input impedance looks like beta times this. If beta is 100, base input impedance is 100k, unless the biasing arrangement upsets the value.

The other input configuration is grounded emitter—or something closer to that than grounded collector. Usually, the emitter will have a much lower resistance value connected between it and supply than that between collector and the other supply terminal (*Figure 3*).

Now comes the question of optimizing this circuit. The input stage has to meet two requirements that in some degree conflict: it must provide a satisfactory input load for the microphone or pickup connected to it; and it must provide the maximum possible gain, to raise signal as rapidly as possible above a level where, from circuits and other sources, noise constitutes a hazard.

Idealized theory tells us that maximum power—and thus by implication level—transfer occurs when source and load impedance match. Thus, the microphone or pickup impedance should be identical with the input impedance provided by the base-to-ground connection of the transistor circuit, in its operational condition. But practically, it is never as simple as that, whatever your professor may have told you in school.

In the old tube circuit, we could never match the grid input impedance in the power-matching sense, because the grid takes virtually zero power, requiring a voltage at no cur-

(continued on page 25)

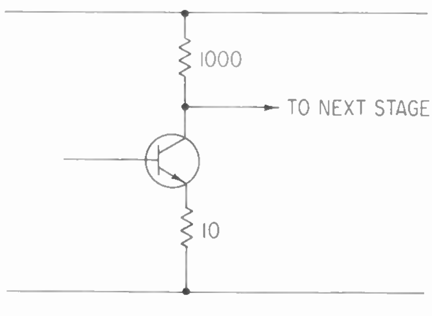


Figure 3. An essentially grounded emitter circuit uses a much lower value emitter resistance than collector resistance, and takes the output from the collector.

NEW PRODUCTS AND SERVICES

Stereo Ribbon Mic

• This well-known ribbon microphone is once again available in the United States since the Danish manufacturer is now directly represented in this country by a subsidiary. Model BM5 is two separate microphones plugged together to make a stereo unit characterized by wide dynamic range, low distortion, and smoooh extended response. The two elements can be rotated up to 90 degrees relative to each other with the angle indicated on a calibrated scale. A music/talk switch is included for close work because of the inherent tendency of ribbon mics to over-emphasize low frequencies when used at distances less than 3 feet. A table stand is included.

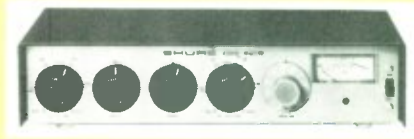
Mfr: Bang & Olefsen
Price: $99.95
Circle 42 on Reader Service Card

Amplifier/Preamp

• Model 1109 is the vanguard of a new series of amplifier and equalizer modules. The 1109 is 600/150 ohms bridging input with dual 600-ohm outputs. Gain is adjustable through a 20 dB range and, depending on input strapping and termination will range from 30 to 56 dB. Output power of each of the outputs is +24 dBm and if they are paralleled, +27 dBm can be achieved. Noise is within 2 dB of the theoretical limit. Power requirements are either +24 to 30 V d.c., or 15 V d.c. The board is a 2 3/4 by 6-inch glass epoxy card with gold plated contacts that mate with a standard 15-pin connector.

Mfg: Universal Audio (UREI)
Circle 2 on Reader Service Card

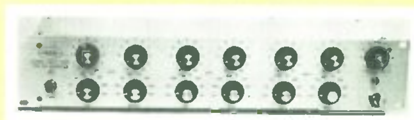
Audio Control Center



• The M63 Audio Master is a frequency-equalizing audio control center for both recording studio and broadcast applications. The unit will convert the output device to a remote amplifier—with equalization—in broadcast stations, it will equalize music and program material in broadcast and recording studios, function as a frequency shaper to reduce feedback and enhance sound quality in reinforcement systems, and provide audio control and monitoring facilities in multiple mixer applications. Bass and treble controls along with variable high-pass and low-pass filters and a volume control give the unit its capabilities. It accepts two high-level inputs, and has outputs for headphones, 600-ohm balanced line, high/low impedance mic level, and auxiliary high impedance, high level. For monitoring applications, the unit has an illuminated vu meter.

Mfr: Shure Bros., Inc.
Prece: $160.00
Circle 40 on Reader Service Card

Program Equalizer



• Low frequency shelf boost and cut is variable up to 15dB at 30, 60, 80, 120, 150, 200, 300, and 500 Hz. Mid range peak boost and cut is variable up to 10 dB and covers the discrete frequencies of 250, 350, 500, 700, 1000, 1400, 2000, and 3000 Hz. At the high frequencies, boost and cut is again 15 dB and the frequencies are 2.5, 4, 5, 6.5, 8, 10, 12, and 15 kHz. Input and output is 600-ohms transformer isolated. Noise is 80 dB below +4 dBm. Distortion is 0.2 per cent at +23 dBm maximum output. The unit fits a standard rack mount, is a.c. powered (20 watts 50 or 60 Hz), and takes 3 ½ inches of panel height.

Mfr: Martin Audio Corp.
Price: $575.00
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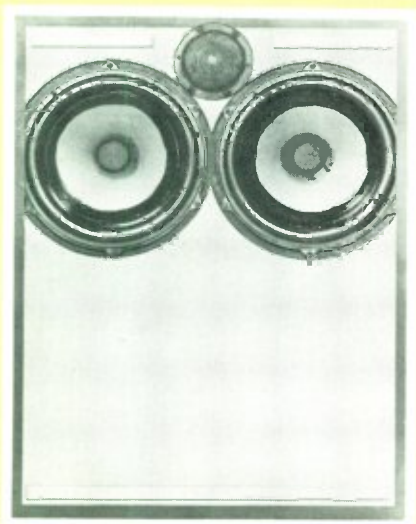
Monitor Speaker



• The A-50 aperiodic loudspeaker has dual-spectrum damping—a new design that is claimed to both extend low frequencies while providing effective damping. These dual benefits are achieved by using two high-compliance woofers and two airtight cabinet compartments connected through an acoustical resistance. A non-inductive crossover network directs frequencies above 1 kHz to a separate hemispherical soft-dome tweeter. The cabinet itself is free-standing and slim-line with dimensions of 28 by 21 ½ by 10-inches deep. The grill clotch is Velcro secured.

Mfr: Dynaco, Inc.
Price: $179.95
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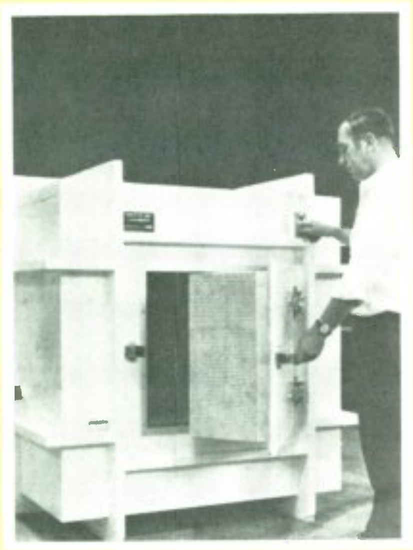
Portable Anechoic Chambers



• This new line of portable chambers has been designed to facilitate the study of the acoustic properties of small mechanical equipment, devices, as well as the calibration of microphones. These series P chambers offer performance that is achieved within a sound attenuating cabinet (including the access door) that is lined with pre-tested An-Eck-Oic wedges. In addition, the floor system is non reflecting. Cabinet section joints are splined to prevent acoustic leaks. A sound absorption level of between 99 and 100 per cent therefore is easily maintained within the chamber. Eight standard models are offered with free-field volumes ranging from 25 x 25 x 25 inches to 69 x 69 x 69 inches. Cutoff frequencies are 150, 200, or 250 Hz.

Mfr: Eckel Industries, Inc.
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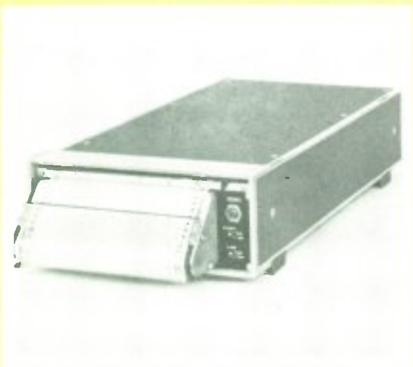
Strip Chart Recorders



• These new recorders use a linear servo motor pen drive to achieve utmost reliability. They are only 3 ½ -inches high so they conserve rack space, yet have a versatile chart drive and viewing system. Adapting the linear motor to a chart recorder results in a drive system that has only one moving part —the motor/slider/pen assembly. Because the entire radial field of the motor is produced by a permanent magnet, the motor consumes little power and has virtually no internal temperature rise. The motor can be driven continuously off scale with no noise and no damage to the recorder. The slanted chart viewing system provides easy access to the chart as it is either rolled up or torn off. Two models are available: The model 7123A/B uses 10-inch chart paper and has a less than 1/3 second full-scale response, while the model 7143A/B takes 5-inch paper and has a full-scale response of less than ¼ second. Input ranges from 1 mV to 100 V, single span, are specified by option. Chart speed is also determined by option choice as is the option of electric writing.

Mfr: Hewlett-Packard Co.
Price: Model 7123—$750;
Model 7143A—$695.
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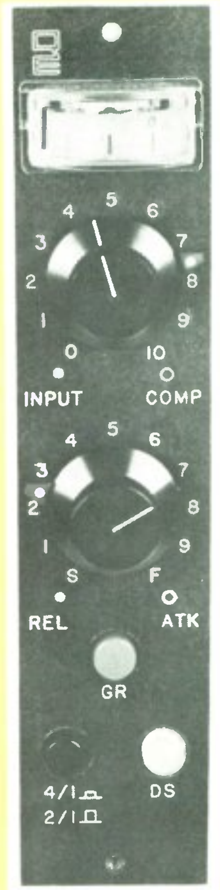
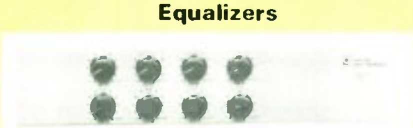
Modular Compressor



• Model Auto-Mix 2B offers the two most useful compression ratios for modern music recording and dialogue. These are the ratios of 2:1 and 4:1. Continuously variable attack time is provided. This permits deliberate use of slow attack times. There are also ten curves of de-essing which function on either ratio. Separate input and compression controls achieve a 90 dB s/n at all compression conditions. For custom installations, all controls may be remotely controlled. Power requirements are 28 V d.c.bi-polar regulated. At full rated putput 30 mA are required. A 36-pin p.c. connector is provided.

Mfr: Quad-Eight Electronics
Price: $250.00
Circle 5 on Reader Service Card

Equalizers



• These are two models, similar looking, of a new equalizer designed to work with this company's EM-7 echo mixer. Model PEQ-7 is a four-channel peaking type equalizer. It features two low-frequency peak frequencies (40 and 100 Hz) and five high frequency peak frequencies (1.5, 3, 5, 10, 20 kHz). Boost or cut at the selected frequency can be inserted in steps of 2, 4, 6, 9, and 12 dB. The unit has integrated circuits and has zero insertion loss. It plugs directly into the EM-7 system. The second model, EQ-7B is an i-c version of this company's EQ-7 shelfing type equalizer, it features zero insertion loss, extremely low noise (86 dBm) and an equalization cabability of 15 dB at each of the frequency extremes. This unit also can be plugged directly into the EM-7 mixer.

Mfr: Gately Electronics
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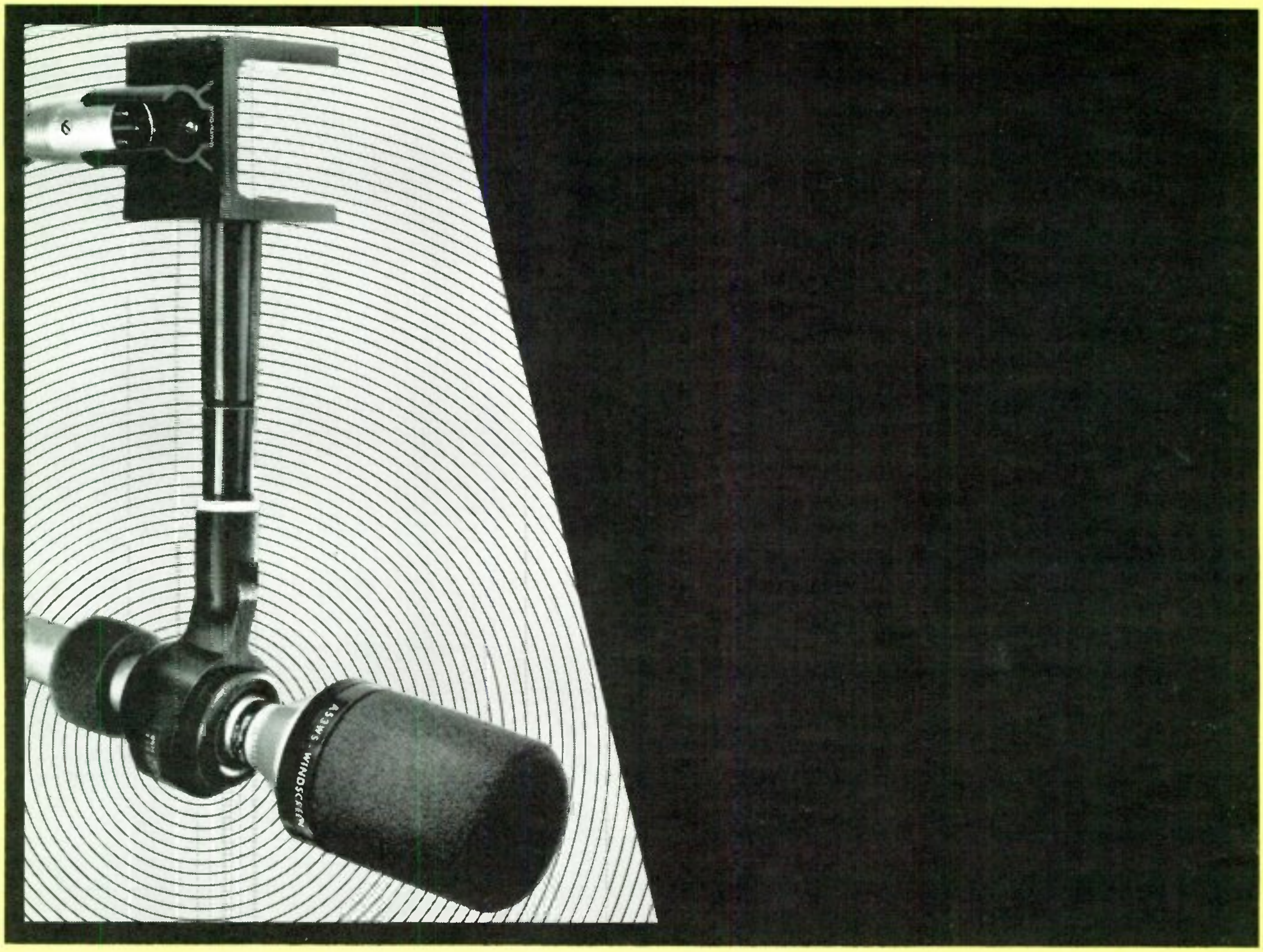


Boom Boon.

We've taken our most versatile, best-performing unidirectional studio microphone, the *Shure SM53,* and made it even more versatile by developing a complete boom accessory system that equips the SM53 for every conceivable boom and "fish-pole" application! Shure design engineers started with a major breakthrough in design: a small, lightweight, extremely effective isolation mount. They developed a super-flexible isolation cable, a pair of highly-efficient front-and-rear windscreens, and a 20" boom extension pipe. Finally, they developed a complete boom assembly that combines unusually small size with superb control and noise isolation. Result: an accessory lineup that makes every Shure SM53 studio microphone a complete microphone system! Write: Shure Brothers Inc., 222 Hartrey Avenue, Evanston, Illinois 60204.

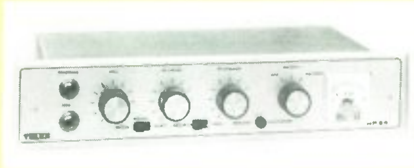
SHURE

Circle 27 on Reader Service Card

Spectrum Analyzer

• This sophisticated audio measuring device is basically a swept frequency spectrum analyzer operating from 10 Hz to 50 kHz with a 10 Hz resolution. A 1.0 volt signal is available on the front panel which tracks the local oscillator and permits frequency-response measurement of amplifiers, filters, loudspeakers, and microphones, as well as attenuation and isolation in circuits and components. The local oscillator and the sweep generator can be swept either in a linear mode for display on the 7 x 10 cm crt or in a log frequency display for expanded lower-frequency analysis. The model 710/801 is battery-operated and covers the frequency range of 10 Hz to 50 kHz.
Mfr: Systron Donner Corp.
Price: $3250.00
Circle 37 on Reader Service Card

Record Preamp



• Model RP-84 is a versatile professional record and playback preamplifier specifically designed for magnetic tape recording and playback with standard NAB calibration. The all solid-state unit can be used with either two or three-head tape transports and includes an a-b monitor switch. An equalization selector switch and a slow/fast speed switch match the unit to any tape transport operating from 1 7/8 to 15 in./sec. Bias adjustment provides optimum record level and an over-all frequency response of 30-18,000 Hz, 3 dB at 7 ½ in./sec. The preamp can be used with quarter-, half-, and full-track head configurations and provides mixing of mic and line inputs. It has a high-impedance phone jack, vu meter, record light, and record interlock. The bias oscillators of several preamps can be synchronized for multi-channel applications.
Mfr: Telex Communications Div.
Price: under $145.00
Circle 44 on Reader Service Card

Ready-To-Use Console

• Up to 28 inputs and 16 outputs in a console measuring only four feet in width are provided by this new entry. It is delivered fully wired and ready to operate. The concept behind the design is a fully modular console using plug-in components that will never become obsolete as the studio's requirements grow. The console can be expanded in capabilities through the simple expediency of addint this company's plug-in wired modules. Modulite volume level indicators are used that offer a virtually instantaneous following of the audio envelope with a sequencial pattern of colored lights.
Mfr: Altec Lansing Div.
Circle 38 on Reader Service Card

Effects Catalog

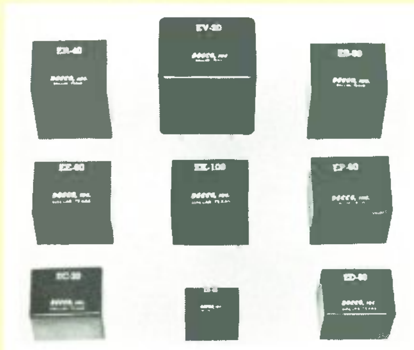
• One of the wildest, most interesting catalogs to come to our attention is the 120 page catalog entitled *World Wide Sound and Music Library* of Cinema/Sound International of New York City.

We guarantee that you won't put it down once you start leafing through its contents of sounds. It is rich in its completeness. As an example there are 39 types of Farm Animal Sounds ranging from piglets snorting to a cattle stampede complete with hooves, rumble, moos, and bellows. There must be over 400 automobile sounds of every description and this is only through A!

Also included is a series of tapes of Fairs, Festivals and Celebrations recorded around the world from Northern Ireland to Nigeria, from Norway to Singapore. A large number of American events are also covered—such important holidays as the International Brick and Rolling Pin Throwing Contest in Stoud, Oklahoma and the always touching Watermelon Festival held in Hampton, S.C. But don't go away. A section is devoted to News Events, Historic Voices, Campaign Songs plus Musical Listings. The news events date from original wax recordings of pre-1910 vintage (Robert Peary and William McKinley, etc.) to the present. You can select the only known recording of Lenin, or hear Alf Landon, or Princess Elizabeth saying good night to British children, etc. This section is topped off with a Library of Campaign Songs, Incidental Music and Historic Voices. All in all it is a most imposing task, well done, extremely well documented and indexed and probably the world's largest sound library.

We suggest you write *Cinema/Sound Ltd. 56 West 45 St. New York, N. Y. 10036* for your copy. If you can't wait the phone is 212-799-4800. Tell them **db** sent you.

Power Transformers



• A new line of power transformers features miniaturization and plug-in capability. The "E" line ranges in nine different case sizes from 1 to 10 cubic inches. They are designed for use in low to medium power supplies, control and isolation circuits, small lighting, etc. A choice of voltages ranging from 6 to 115 V in fourteen increments is available in each of the nine case styles with delivery capabilities of from ½ watt to 26 watts of continuous power.
Mfr: Decco, Inc.
Price: 100 pieces—$4.00—$7.00 ea.
Circle 41 on Reader Service Card

(continued from page 20)
rent—or so little as to be meaningless as a measure of power level. In that condition, the objective was to achieve the best, or maximum voltage transfer, consistent with achieving a satisfactory frequency response or other performance criterion.

In the transistor circuit, similarly, the objective becomes that of achieving the maximum current transfer consistent with similar other criteria. While the transistor, admittedly, comes nearer to being a power amplifier than does the tube, because it can amplify both voltage and current components of signal, pure matching theory does not apply without modification. The fact remains that the transistor is basically a current amplifier—it uses essentially current input, just as the tube uses voltage input.

As the tube achieves matching by assigning an impedance to the grid, which may be realized by use of an external grid resistor, so the transistor achieves matching by modifying the base input impedance to suit. When the emitter is actually grounded (no resistor between emitter and ground) the base input impedance is low and quite non-linear. So an emitter resistor is needed to linearize base input impedance.

Thus, if the transistor of *Figure 4* has a beta of 100, using a collector resistor of 1,000 ohms, and a bias resistor of 100k from collector to base, bias is stabilized so collector current maintains a collector voltage close to half supply voltage as operating point. If the following stage input impedance is 500 ohms, the collector load is 333 ohms (1,000 in parallel with 500).

So the feedback fraction, for signal, is 333/100,000, or 1/300. With a beta of 100, this reduces gain to 3/4, or 75, of which 2/3, or a current gain of 50, reaches the following stage. This is virtually fixed, regardless of the emitter resistor value, which will merely change the input impedance.

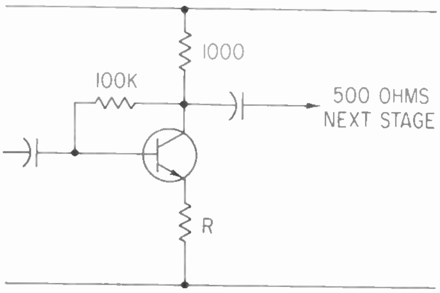


Figure 4. Detailed consideration of this circuit illustrates relationships in transistor input circuits.

As the working gain of the stage is 75 (this transistor has no means of knowing that only 2/3rds of this reaches the next one) the impedance reflected by the emitter resistor into the base circuit will be 75 times the value of the resistor chosen. This is what determines matching.

Now assume that a microphone has a purely resistive impedance of 600 ohms: an emitter resistor of 8 ohms will cause the amplifier input to match this. Current gain will be 50, and voltage gain 41.7. Assume the microphone, for a certain sound input, generates 6 mV signal, open circuit. It will deliver 6/1,200 = 5 microamps input signal which, multiplied by the current gain of 50, will pass 250 microamps signal to the second stage.

Now, halve the emitter resistor, to 4 ohms: now the input current from the same signal will be 6/900 = 6.67 microamps, to produce 333 microamps at the second stage. Clearly the *maximum* signal will occur when the emitter resistor is removed altogether (zero value) so the microphone feeds into a short-circuit.

Then the only linearizing effect on the base-emitter input impedance will be the resistance of the microphone itself. In other words, the amplifier will provide fairly linear *current* amplification, but quite non-linear *voltage* amplification, under this condition. If this is good enough then it is the condition that achieves maximum gain.

The emitter resistor will serve to linearize input, so the microphone feeds into a more linear load resistance, instead of a very non-linear (almost short-circuit) impedance, but it will reduce power gain a little.

For the same reason encountered in earlier input matching problems, it may be desirable to make the load impedance higher than the theoretical ideal match. The microphone or pickup impedance may include an inductive component, in which case matching into too low a load value results in loss of higher frequencies.

This loss is not irretrievable and it is predictable, based on the relative inductive component of the microphone's internal impedance. So it may be possible to achieve higher gain, and better signal to noise level, by matching into something close to a short-circuit, and then using a carefully designed high-frequency boost later, to equalize for the high-frequency loss.

This must be offset against any possible non-linearity that occurs due to operating the transistor with zero input impedance (or close to it). True, at the low levels utilized by microphones (or even pickups), the distortion produced by this non-linearity will be low.

The choice will be—or should be—dictated by working dynamic range. Low-level pickup will mean that distortion is less likely to be a problem, which noise is more likely to be. So short-circuit matching (or something approaching it) will achieve best results for this purpose.

High-level pickup will mean that distortion assumes greater importance, while noise is less likely to be a factor. So an appreciable value of emitter resistor will help linearize input, with our prejudicing signal-to-noise ratio, in this case.

NORMAN H. CROWHURST

Tape Duplicating —A Status Report

Tape duplicating for the mass market has become big business. In this state-of-the-art report, the author limits his look to that equipment designed for high-output production of tapes. A future report on small-run duplicators is in preparation.

THE UPSURGE IN AUDIO today is tape—particularly cassettes and cartridges. And by upsurge, I mean mass market, not the small-time high-fidelity fan thing that has gone on for decades. This kind of market inevitably attracts entrants, for in such quantities there is money to be made.

The basic engineering problem attached to producing inexpensive tape cartridges and cassettes in quantity is quite different from the problems that plagued the development of the disc industry a few decades ago. The disc record always was a natural for setting up dies and knocking them out by the million. The problem with tape is that virtually every copy has to be made an inch at a time from the master—however fast the inches may be made to pass.

Before this became a problem, tape needed material that would allow at least reasonable quality recordings to be compressed into a smaller space/time relationship, which is analogous to the progress made from the early 78s to modern LPs of various speeds, all much lower than 78, and with many more grooves to the inch, in disc recording. With each medium, that advancement came through development.

To get a mass-produced, inexpensive tape package, the problem remained to find a means to impress program on the copy tapes at a cost commensurate with the materials. For commercial output has now become a quantity/time problem. Return on investment, and consumer price, inevitably reflects the answer to the question, "How many can we turn out, within a given time?"

Primarily this was a matter of transferring the program to the copy tapes, from a master or sub-master recording. But as this process was accelerated, by making a greater number of copies at a faster rate of transfer, the cost bottle-neck quickly moved down the production line. Next thing, more people were needed to package them in cassettes and cartridges: this became the new limiting cost factor.

Speeding up the transfer of program onto the copies required basic technological development. But packaging was more in the production engineer's customary field. However, another problem, still related to this fact that the program must be transferred, inch by inch, instead of at one "bump", as discs are, was quality control: getting and keeping the reject rate low and, above all, keeping the rejects off the market, as far as possible. For nothing has a worse effect on future sales potential than an appreciable percentage of duds getting out!

A disc can be given reasonably good visual inspection in a few seconds, to achieve virtually 100 per cent quality control. To thoroughly check individual tapes equivalently would necessitate someone sitting and listening to every tape sold, all through: an obviously non-economic requirement!

Those are the basic problems of the tape producer. But to produce, he needs duplicating equipment, and that is what this article is all about, along with questions of philosophy of the people and companies in the business, how they go about solving the problems, and so forth.

Of course, duplicating is not new. The first physical problem is how to get more than one copy made each time the master tape is run through the playback heads, in the purely mechanical sense. The electronics end is relatively simple. The master tape output can always feed a bus (at whatever level, that is a matter of choice) that in turn energizes any desired number of recording heads for making copies. But how do you make sure all the tape speeds are correct—identical—as the transfer is made?

In the early days, the late Robert Marshall developed a very fine machine that solved this problem purely mechanically: a machine used by Dubbings Electronics for many years. It had a single master capstan, that rotated solidly, driving master tape and all the copy tapes on the same shaft. It was a solidly-locked mechanical synchronization.

Bob had his problems making all the transports work, to avoid subsidiary problems such as tape flutter and its associated ills, but he was a fine mechanical engineer, and he finished up with a good machine, that occupied much less floor space than the newer master-slave sets that have since monopolized the field. So why is everybody using these master-slave sets, electrically or electronically coupled, today?

The basic reason for this choice is similar to the problem the airlines have: the planes are only earning their keep—amortizing their cost—when they are in the air;

Norman H. Crowhurst is an engineer, an author, and a teacher. He is a regular columnist with **db** *Magazine.*

The problem with tape is that virtually every copy has to be made an inch at a time . . .

in the same way a duplicator is only paying when it is running, actually transferring program from master tape to copy tapes.

The time taken to load the system up is virtually down time. So is time taken to rewind the master, ready to make another run. True, the latter operation can be performed on a separate machine, freeing the duplicator for only forward motion. But even that involves extra handling.

A vital step, and one now universally accepted for duplication of tapes for cassettes and cartridges, is the use of an endless tape bin for handling the master. By this means, as soon as one pass is completed, the beginning is there ready to start the next, with absolutely no waiting. The master can run through and through and through, endlessly, without wasting any more time than is needed to provide leaders on the finished tapes, according to the type of container—cassette or cartridge—used for the finished product.

Looking at the tape in a bin, running, it seems a miracle it does not get hopelessly tangled—all those loops, wriggling and squirming, as it goes in one side and comes out the other. While it operates well most of the time, variation in bin design shows that problems have occurred.

Design of the bin varies. Some use glass fronts so the tape can be seen at a glance at any time. Some are vertical, some sloping. Some use suction or air pressure to keep tape from bunching so it jams round the intake, where it passes through the transport.

Loading the bin uses slightly varying procedure, from machine to machine, but is basically simple and essentially the same. The lead end is anchored at the point where it enters the transport, while live tape from the storage reel is fed through the transport into the bin, until the whole program to be duplicated is in the bin. Then the two leader ends are spliced together, and the master is "ready to go".

When a run is finished, the splice is undone (it uses a tape to facilitate this) and the master is once again wound onto its storage reel.

With this procedure available, it becomes merely a matter of making sure that, for most of the time at least, this endlessly repeating master is making a maximum number of copies. To achieve this, the tape load in the slaves, each of which receives program from the same master, can be reloaded, one at a time, without stopping all the other slave machines. Down time is fractionalized.

Say it takes an expert reloader 20 seconds to remove a finished roll of tape, with however many copies on it, and reload the machine with a fresh roll of tape. And suppose the one master is feeding a dozen slaves. This way, each slave machine is down for only 20 seconds, every so many copies. The other way, where the master is stopped and restarted, assuming only one operator, all the slaves are down for 12 times as long, or 4 minutes, plus any time needed to prepare the master for another run.

What this 4 minutes means, of course, is relative. If the reload was needed only once an hour, it is not bad. But if a reload is needed every 10 minutes, the 4-minute break time begins to represent a considerable loss. And this relationship depends on how many copies are run at a time, and how fast.

Most of the tapes made play at 1-7/8 or 3-3/4 in./sec. Let's assume a particular tape plays 30 minutes per track, some are longer than that. They can be recorded at 30, 60, 120 or 240 in./sec., which represent 16, 32, 64, or 128 times the slower playing speed of 1-7/8 in./sec. This means the tape will take just under 2 minutes, 1 minute, half a minute, or 15 seconds, respectively, to record each cassette- or cartridge-full of tape.

The master tape may or may not be physically the same as the copies made from it. Most master tapes are wider, such as 1 inch, allowing wider tracks and better signal/noise ratio than can be achieved on the copies. Many masters also play at higher speed, 7-1/2 or 15 in./sec., for copies that will play at 1-7/8 or 3-3/4 in./sec. This means that the master machine must run at from 2 to 8 times the speed of the slaves in making the transfer, so the ratio of the transfer speeds is the same as the ratio of the normal playing speeds.

For example, if the master plays at 7-1/2 in./sec. and the copy at 1-7/8 in./sec., the master machine may run at 240 in./sec. and the slave at 60 in./sec., both 4:1. Or speeds of 120 and 30 in./sec. would serve. *Table 1* shows available speeds on equipment shown to the writer by six manufacturers when he was collecting information for this article. These should not be taken as final, because this is a rapidly changing field, and the table merely shows the state of the art a few months ago, as you read this.

A dozen or so such units of recorded track may be transferred onto a continuous roll of tape by each slave machine at one loading, later to be divided and put into individual cassettes or cartridges. Assuming an even dozen are made in each roll, the loading will take from 24 minutes down to 3 minutes, according to the transfer speed used. This begins to put the whole transfer operation into perspective.

That covers the mechanics of transferring tracks from master to a number of copies, via slave machines. It does not yet get down to the details of how 4- or 8-track tapes are produced, whether all at once, or in successive passes through the machine. Both methods are used, by different people. Nor does it resolve many minor problems, both mechanical, electronic, and a combination of both, that can arise.

Some of the slave machines come with inter-changeable heads and electronics to go with them, so that various types of tape can be made on the same set of machines, after appropriate modifications. While the

TABLE 1

Maker	Master Speed				Slave Speed			
	240	120	60	30	240	120	60	30
Ampex		X	X	X			X	X
Electrosound		X					X	X
Gauss	X	X	X		X	X	X	
GRT	X				X	X		
Otari	X	X				X	X	X
Vega	X	X				X	X	

Table 1. Transfer speeds on current model tape duplicators

Speeding up the transfer of program onto the copies required basic technological development . . . the program must be transferred, inch by inch, instead of at one "bump", as discs are. A problem was quality control: getting and keeping the reject rate low and, above all, keeping the rejects off the market, as far as possible.

usual practice will be to run as long a run as possible of one type, or catalog number, before changing to another, in order to reduce down time while such changes are being made, for many operators of duplicating equipment, working under pressure of customer orders, flexibility at high speed is an asset.

Some machines make a feature of being able to switch from one type of production to another in a matter of seconds. Of course, the precise time depends on the simplicity of the operation involved, the familiarity of the operator with the necessary operation, and the degree of readjustment, if any, needed to align the new mode.

This discussion leads to the choice of philosophy for integrating the record heads with the electronics that drive them. Some prefer to have a high-level (power) bus that provides enough energy, both audio and bias, which must be in the region of several megacycles to correspond with normal bias at playing speed, to feed all the slaves that will be used, in such a way that disconnecting individual slave units does not influence the level fed to those remaining connected.

Others prefer packages with an attached printed-circuit board so that the electronics for driving the heads can be pre-adjusted to suit the particular head on which they are assembled, and fed from a line-level bus.

Still others prefer to have separate electronics for each head in the system, but to mount all the electronics at a central adjustment location, rather than having them distributed in proximity to individual heads.

There are pros and cons for each method. For one-person operation, it would seem that the choice rests between the power bus or the integrated package arrangement. In either case, the adjustment is local to the individual heads, and need not interfere with the setting of any other slave machine. These methods have the further advantage that the transmission level avoids susceptibility to spurious pickup, such as hum.

The foregoing comments apply to producing quantity outputs of tape in cassettes and cartridges. However, reel-to-reel tape is not dead, by any means, nor is it likely to be. So all duplicating machines make provision for reel to reel, by eliminating the master bin—and they need the reels for loading and unloading the bin, anyway —and providing regular, rather than bulk reels on the slaves.

On the other hand, reel to reel can also be made by bulk process, using the bin and making a number of runs on each slave using bulk size reels, the tape from which is later cut up for individual market size reels, just the same as for cassettes and cartridges.

Having transferred program from the master tape to however many slaves are working at once, each producing however many runs of the program at a loading, you have spools and spools of multiple-unit tapes coming off the duplicator, and needing to be packaged in cassettes or cartridges at corresponding handling speed, if a bottle neck is to be avoided.

This leads to various approaches to automation in loading the section of prerecorded tape into their cassettes or cartridges and packaging them, on down the line. Few if any production lines are yet completely automated, as this is being written. But the ingenuity of the more progressive designers is rapidly moving in that direction. In complete automation, ideally, raw tape would feed in at one end, and packaged cartridges or cassettes would come out the other, already quality checked and packed, ready for shipment.

Automatic loading of cassettes or cartridges can be performed very quickly by using tape markers that trigger the machine when a run of program is completed. These markers are inserted by the master, between the end of one run and the beginning of the next.
These markers are inserted by the master, between the end of one run and the beginning of the next.

A 250 Hz tone, for example, recording at 240 in./sec., will be just about 2 Hz at 1-7/8, and thus inaudible at playing speed: the tape player just will not amplify such a frequency. The audio being recorded is transferred at 128 times the playing frequencies, which will be in the kHz range and up, and thus inaudible, or well beyond the audio range, when run through a head at 240 in./sec.

Thus a 250 Hz or similar keying tone can easily be picked up in a high-speed winding operation, and at the same time it will be completely inaudible on the finished tape, when it runs at its normal playing speed. The tone triggers an automated cutting device and/or whatever else is needed, with or without an operator's aid, to start another cartridge or cassette being loaded with the next run of tape.

Quality control can mean various things. One thing to look for is drop-outs on the tape. This can occur, due to weak spots in the tape coating, or due to failure to maintain absolutely uniform contact pressure while the tape crosses the recording head at the high transfer speed.

To minimize the latter, several duplicating machine manufacturers use two capstans, one before and one after the heads, with the shortest possible linear distance between them. As well as eliminating drop-outs due to varying tape pressure against the heads, this also minimizes scrape flutter.

Gauss Electrophysics employs an interesting method of maintaining uniform tension through this short but important distance of high-speed moving tape: both capstans are driven by synchronous motors, but the lead capstan is very slightly larger than the following one. This causes the lead motor to be dragged slightly below synchronous speed, while the trailing one is pulled

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slightly ahead of synchronous speed, the force created by this (electrical, not physical) slip controlling the tension of the tape as it passes over the heads.

Other aspects of quality control need to check for drop-outs due to variations in tape quality, perhaps, or to verify that recording quality is up to snuff. Variations in tape quality, for effective control purposes, must be checked continuously, virtually 100 per cent—at least on sample runs.

One way to do this is to provide the slave(s) with playback heads, that monitor the program impressed continuously, checking its level against the recording level a split second earlier, when the same point on the tape passed the recording head. This is only a level check, but it can be made highly reliable.

Checking for quality of recorded program involves listening to spot checks on the tape, and can only really be performed as a sampling operation. Of course, the more other checks that are provided, the less likely is any variation in quality of recorded program to escape detection.

As in any recorder, change of bias setting, or any other deviation, electrical or electronic, can interfere with quality. So output from each recording slave should be quality checked every so often.

Another quality control check concerns cartridges particularly, where a fault can occur that will impair the running of the tape, not necessarily due to any defect in the recorded program or associated with it. This could cause the tape to hang up at some point in its rotation through a playing machine.

One test for this performs a 100 per cent check on cartridges in batches, without listening to them. It uses the sub-audio key tone to determine when the whole tape has gone by and alerts the operator if any cartridge in the batch fails.

Practically all the manufacturers have made flexibility a key feature of design, so that each machine can be rigged to do the maximum variety of jobs. However, while one manufacturer aims at flexibility with his own line, to achieve change you need different units from that manufacturer's line; others aim at maximum compatibility, so individual units from that manufacturer can be used in combination with as many of his competitor's systems as possible.

Some manufacturers have devoted their attention to producing a duplicating system, or some particular part of it, for sale to people in the duplicating business. Some of these have designed improved cassettes or cartridges, yielding better handling of the tape, primarily intended for use in their own facility, but having it available, they find a market for that too, to other duplicating houses.

The name with the background in the business is, of course, Ampex. Their machines were successful, from the first, because of their solid design: they are durable. As several of the newer companies were started by, or

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Automatic loading of cassettes or cartridges can be performed very quickly by using tape markers that trigger the machine when a run of program is completed.

else hired, personnel formerly with Ampex, it is only natural that most of them perpetuate the same notion of ruggedness in design. That is as the fundamental principle taught in the school from which they graduated. One might even say they are over-engineered.

Of course, over-engineering for this kind of work is a good "fault". Failing to hold up can be a far more costly fault, so it is better to have a truly great margin of safety—a machine that will produce good, though not perfect output, even when it is persistently abused—than to try to engineer for some sort of economic optimum. The economics come in the time/material relationship of production materials, not in the tools used—the equipment.

We referred earlier to the choice between making 4 to 8 tracks (or even more, when they can squeeze more onto the tape) all at once, and making them tracks (that's for stereo) at a time, requiring more than one pass through the machine. Doing the whole operation at once, putting on all the tracks in one pass, saves time, but requires more electronic equipment and greater precision in the total adjustment, for perfect alignment, although most of this precision is cared for in the multitrack head.

On the other hand, making more than one pass enables greater focus to be placed on individual track quality, minimizes cross-talk problems within the head assembly, but imposes another problem: that of getting all the tracks to start and finish coincidentally, or closely enough so that parts of one or other run do not get chopped off in the packaging. This can be achieved by using the same keying codes, put on during the first run, as control to synchronize the starts on successive runs.

This connects with the problems of start and stop, mostly the starts. How soon can the machine come to speed, and synchronize with the master machine, already running? This depends on the type of drive, and it also sets requirements: the tape transport handling mechanism must control tape movement to correspond. Different machines use different types of mechanism to absorb speed changes and settle the whole mechanism down to uniform movement.

Different kinds of motor are used for all purposes, by different manufacturers. For the synchronous drive, some use servo motors, that enable all the slaves to be phase-locked to the master, with the theory that any deviation from synchronism, or any speed change due to supply variations will, in this way, affect every capstan, master and slave, in identical fashion.

Others use synchronous and closely identical drives for master and slaves, so that uniformity depends on this identity.

Then for the feed and take-up spools (which are involved on the slaves but not in the master bin) again different types of motor may be used. A high-slip induction motor can provide fairly constant torque, and thus close to uniform tape tension. On the other hand, a d.-c. motor offers some advantages in controllability.

Some manufacturers have devoted their attention to producing a duplicating system, or some particular part of it, for sale to people in the duplicating business. Others are themselves in the duplicating business.

For quality recording, head quality and the electronics that feed the heads are important. Otari has introduced a unique design using heads of ferrite material, which they claim to be superior and much longer wearing than conventional heads. Most of the manufacturers, who do not use a power level bus, have switched to the use of etched-circuit boards attached to or closely associated with the heads they serve, on which are mounted amplifiers, equalizers, and necessary trimming features.

These are just some of the facets of the ongoing research and development in the field. Far more things can happen to magnetic tape than meet the eye. For example, have you ever noticed that tapes deteriorate with keeping, quite apart from such obvious defects as print-through?

For some time, it has been felt that magnetic tape can be made wear-proof. Mechanically it can. Disc records can wear out, but tapes (even master tapes) can deteriorate by being stored for a long time. Apparently a slow longitudinal demagnetization occurs, especially at high frequencies, where wavelength is short.

For this reason a new recording sounds brighter, sharper, than one that has been stored for some time. This cannot happen to discs, unless they are played, to wear the high frequencies off. However, tape and other research is being conducted, to find ways of overcoming this problem. Meanwhile the more immediate problem is that of issuing the best possible new tapes, to which there are many more problems than we have space here to treat in depth.

One reason for versatility, and for different emphases in the design philosophies used, is the increasing variety of uses for tape. Car stereo, home stereo (which may use the same cassettes or cartridges interchangeably), and various portables, all use conventional program material, of the entertainment variety.

However, there are big customers with nationwide distribution and little customers not so widely known, who may require correspondingly big and little runs on their catalog numbers. So choice of quipment may vary, according to whether the duplicating facility is likely to be making all short runs, all long runs, or a mixture.

For short runs, versatility in making the necessary changes in minimum time is as important as producing quantity at maximum speed, or maybe more so. For long runs, which means large quantities, maximum operating speed, saving every second on the production line, is probably the most important single criterion, with many facets. For mixed runs, the best of both is sought, or maybe some compromise will be needed.

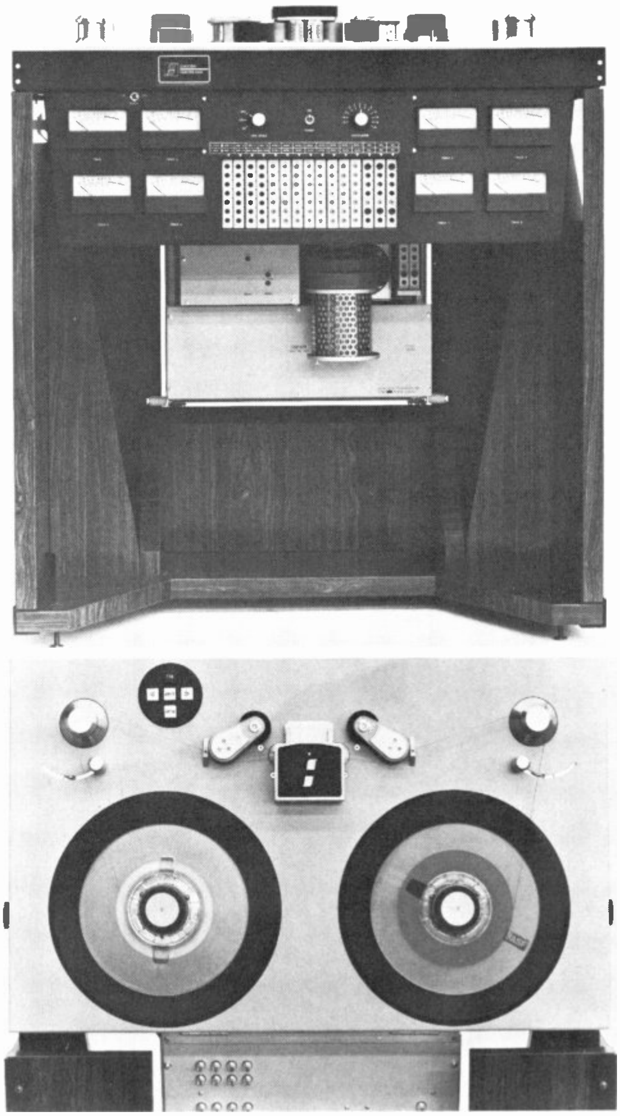
But entertainment media of one kind or another are far from the only uses for recorded tape today. Talking clocks, language and other teaching tapes, functional tape units for an almost endless variety of process controls, the field is endless. ■

A Guide to High-Volume Tape Duplicating Systems

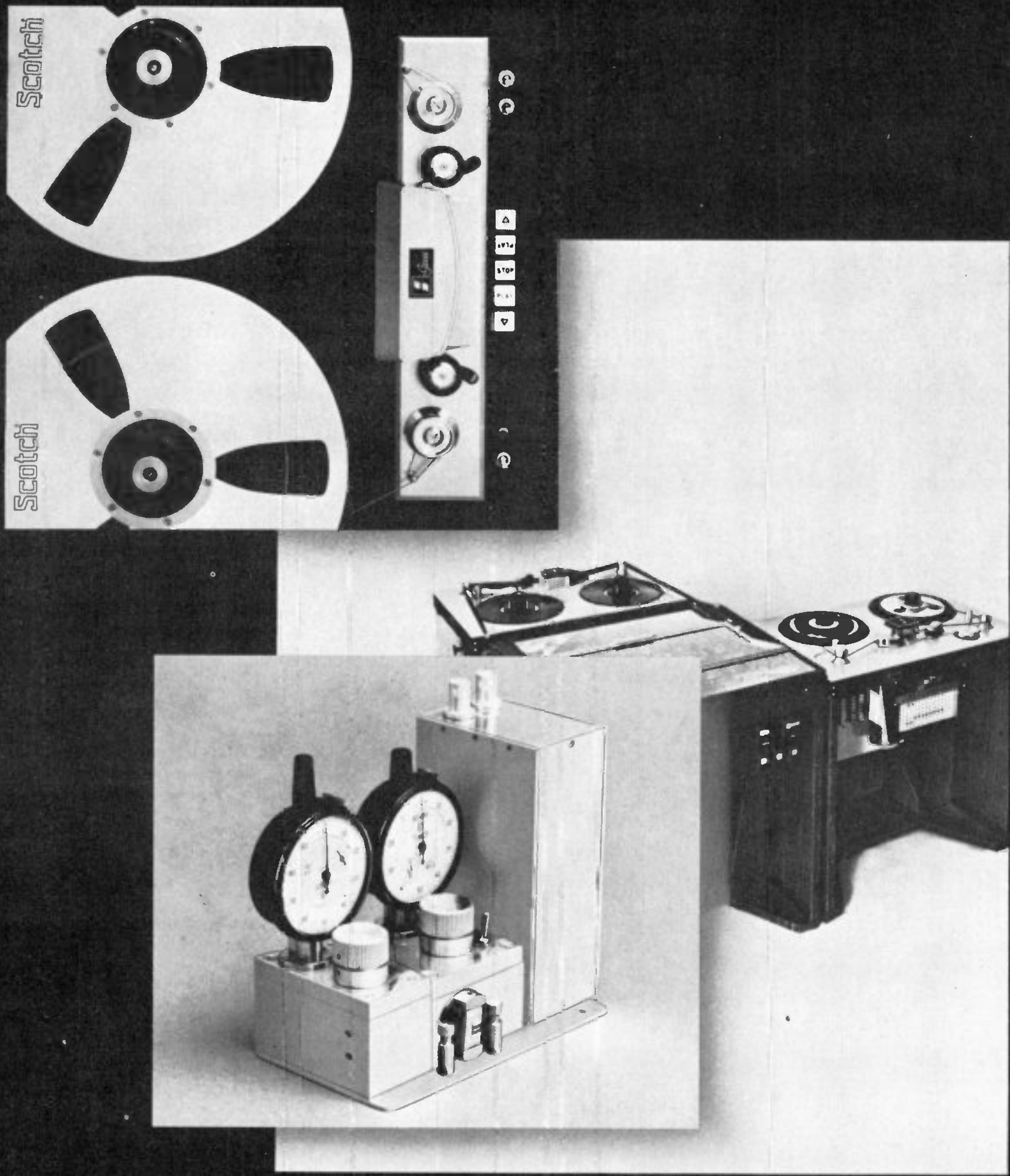
THE FOLLOWING LIST and specifications should not be taken as a total guide to the market. Rather, this represents information available to us at press time on models and manufacturers. In this rapidly developing industry, it is to be expected that new equipment and manufacturers exist beyond this list. We will report on them in subsequent issues.

GAUSS ELECTROPHYSICS

Series 1200—is a high-speed system with the master using reels of tape operating in a closed-loop system using a dual capstan drive with two direct-drive synchronous capstan motors. Servo systems control tape tension. Up to eight tracks are fed from ¼-, ½-, or 1-inch wide tapes. The slaves take 14-inch reels and ¼-inch or 150-mil wide tapes. *Circle 92 on Reader Service Card.*



The Gauss eight-track assembly showing the meters and the electronic part of the controls. In the top view of the transport the closed-loop double capstan system is clearly seen.



PLAY-CHECKERS FOR GAUSS FIDELITY

Tape duplication fidelity was just a buzz word until the Gauss 1200 Series made the scene. Gauss' Model 1250 Reproducer offers strict quality control verification of tapes duplicated in either 1/7" or 1/4" widths. It permits examination of the tape in *real* time.

Gauss' Model 1270 permits visual functional measurement of the tape duplicator throughout the duplicating process, thus permitting examination of the tape *at duplicator speed.* As play-checkers, they're necessary *all the time.*

They're quality standards *set* by Gauss.

by Gauss

Gauss Electrophysics
An MCA Tech. Division
11822 W. Olympic Blvd.
Los Angeles, California 90064
(213) 478-0261

Circle 29 on Reader Service Card

called on the talents of Paul Seiz, currently director of the Museum of Performing Arts at Lincoln Center in N. Y., as associate designer. The total past record of this combination of talents includes such formidable design projects as the U. S. Pavilions at each of the N. Y., Montreal, and Osaka World's Fairs.

The concept that the visitors are entering a fair-like exhibit begins as they mount the steps at the front of the building. A modern fountain, built in what looks like a tree of pipes in a square-shaped pool, creates a ball of spray which falls into the pool, which in turn empties continuously into a lower and larger square pool.

The audience enters through a revolving door in a front wall of glass to the entry lobby of the exhibit. Here, on one wall, is a Burlington family tree made up of hundreds of cones of yarn and indicating, on discs within the spool arrangement, the names of products or divisions of Burlington . . . such well known names as Lees Carpets, Klopman Fabrics, Adler Socks, and Globe Furniture. The entire display is white on white.

The visiting guest then walks under six large rotating psychedelically painted (black and white) fabric pattern rollers onto a slowly moving "sidewalk," which will carry him through the rest of the exhibit. This moving walkway is 208-feet long and is the longest of its kind east of the Mississippi River.

The first exhibit area presents the sources of 6 of the raw materials—wool, cotton, rayon, nylon, polyester and glass fiber. The sound heard through ceiling speakers located over the ramp is electronic music creating the effect of gurgling liquids as though to indicate that the next step is a chemical process leading to materials for the manufacturing machines to use in their phase of the mill operation.

From here, the visitor is led into the largest section of the exhibit areas, the manufacturing plant. Production machinery is set up on three levels to demonstrate *spinning*—the rewinding of packages of yarn onto bobbins; *dye vats*—for quantity dying of yarn spools; *warping*—winding yarn from a number of yarn packages onto a large beam for the weaving or warp knitting processes; *circular doubleknit machines*—for production of doubleknit fabrics from natural and man-made yarns; *hosiery knitting*—producing pantyhose, women's hosiery, men's and children's socks; *hosiery boarding*—a process for shaping hosiery and socks under high temperature and pressure; *Jacquard loom*—weaving of tapestries, brocades, damasks, etc. from a punch-card programmed system; *Sulzer loom*—weaves fabrics at high speeds without a shuttle; *Raschel knitting machine*—produces warp knit fabrics with lacy and open effects as well as smooth surface patterns; and *tufting*—production of loop and cut pile fabrics for carpets, rugs, and bedspreads.

To enhance the effect of size of the mill area (40-feet high), the walls of this area are all mirrored so that the expanse of the actual size, as viewed from the moving ramp, is an illusion of immense proportions.

Mirror-walls also permit the viewing of rear sections of the machinery as well as the machines located on the lower level and also under the moving ramp.

As each of the machines makes its own sound and the total din of the area, under normal circumstances, would be almost unbearable, each of the machines is

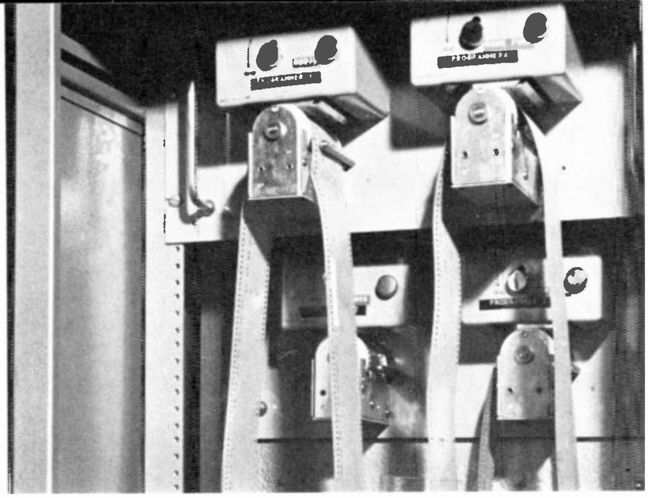


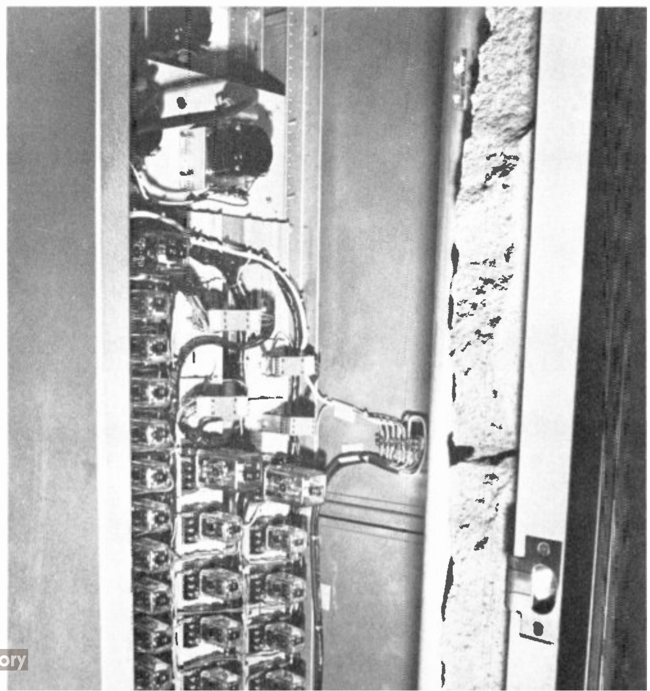
Figure 2. The control programmers for the slide projectors.

damped to decrease the sound it makes during movement as much as possible. Some of the units were modified to reduce the actual sound made to almost a complete silence. The true sound of each machine is then reproduced through specially selected sound columns for the high frequencies and bass speakers for the lower frequencies, both of which are located in the vicinity of the machines but disguised. The sound is then programmed so that only one machine sound is heard at any one time and a flashing arrow indicates which machine's sound is being reproduced.

It was found to be unfeasible to stop and start the individual machines as the sound was heard, and the method presently being used is quite effective, in spite of the fact that all the machines are moving continuously but only one sound is heard. The only machine not programmed for sound reproduction is the dye vat unit. This machine operates independently. As the cover lowers and the spools descend into the dye, steam (created by dry ice being lowered into water) rises from the inside of the unit and as the lid hits a microswitch on the way down, a hiss sound is heard.

The next part of the exhibit is most as what would be expected at a modern fair display. The entire length of the wall of this diorama is made up of a total of 69

Figure 3. The control relays located in the programmer rack behind the four projector control units. Above the relays you can see the motors for the programmer units as seen in Figure 2.



rear-screens *(Figure 1)* ranging from about the size of a small TV set to about 4½ by 6 feet and extending from slightly below the walkway all the way to the ceiling.

The screens are placed so that some are at the wall surface, others are slightly in front and others still farther forward toward the viewers. The display is divided into several sections. One segment, shows figures made of different parts of the body dressed normally but arranged to create a human that is quite unreal but amusing. Another section shows a chair with diverse covering material patterns while adjacent screens show various patterns or blowups of the material. Still others show windows with patterned curtains or athletic activities in which material is used for different purposes. The last section displays logos or labels of Burlington or subsidiary companies. For a more dramatic effect, each segment is programmed separately to change projectors that carry related images in a uniform pattern. The music, is called *Mill Rock* and is distributed through three specially-designed speakers placed at ear level on the moving ramp and spread across the width of the exhibit area and hidden in the black wall between screen boxes.

The exit area has 6 more "fabric" rollers revolving over the heads of the visitors as they step off the moving sidewalk. In the lobby, visitors are shown a map with pins indicating the locations of Burlington offices and plants, facts and figures about Burlington and its divisions on continuously rotating closed-loops of material moved by revolving rollers to simulate the operation of computers.

The total result of the Mill presentation is the multisensory experience of following the production of textile and related materials from source through manufacture to final use in every-day existence. The techniques used to present this brief (8½ minutes) tour of the mills are modern and unique. The rear screen projection area is the latest and largest industrial application for a permanent exhibit since the technique was first used at a recent World's Fair.

Figure 5. The author is seen starting one of four amplifiers/tape decks. Each amplifier has a monitor speaker which can be cut off by the switch below it. During the check-out period at down time, test levels are set.

As the visitor leaves the rear of the exhibit, and walks around the building on the side street, he is presented with a further experience, visible only from outside the building. Nearly 200 different colored fabrics are mounted in 175 squares, each four feet by four feet, and with a total of over 1,000 blinking lights bordering the squares. The center of this wall of fabric is left open so that persons looking into the exhibit area can see the machinery. The solid portions of the wall are used to block off the light from the outside from the raw materials and end-use areas of the exhibit.

The Mill opened on Sept. 10, and will remain open indefinitely. The display is open to the public each Tuesday through Saturday, from 10AM to 7PM. Admission is free.

All the control and sound amplification equipment is

Figure 4. These lamps pin point a projector lamp that has failed. Switches below the lights are to preset programmers for continuous (normal) operation, or for one cycle after which the programmer is automatically stopped by a punch in the tape in the last channel.

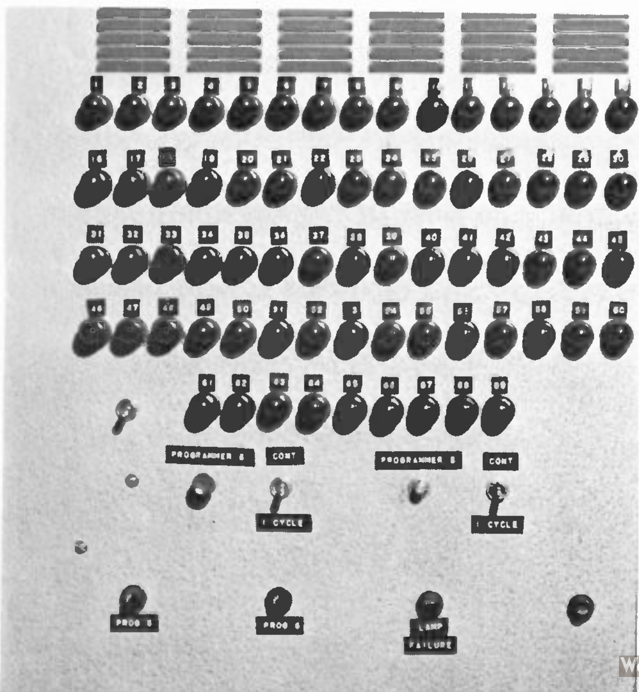


Figure 6. Backstage at the Mill in the projection area. Note the perforated steel platforms on which the projectors are mounted.

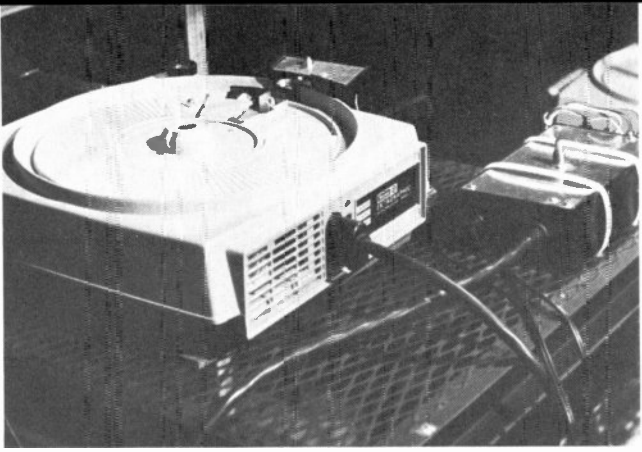


Figure 7. One of the standard projectors. Note the microswitch mounted at the zero position on the unit. At the right is the control box.

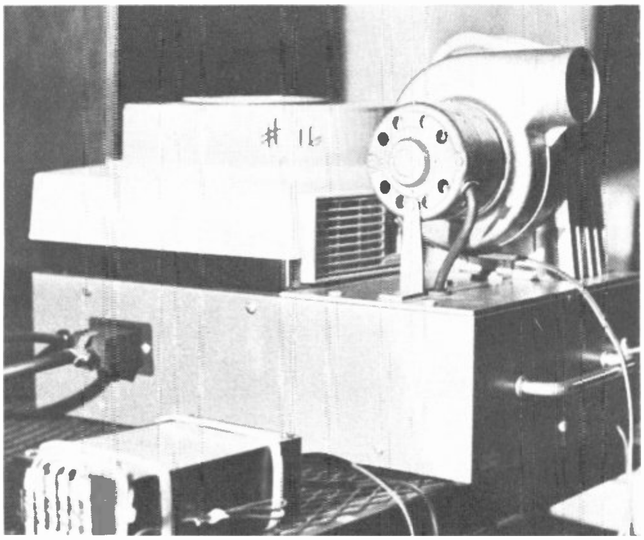
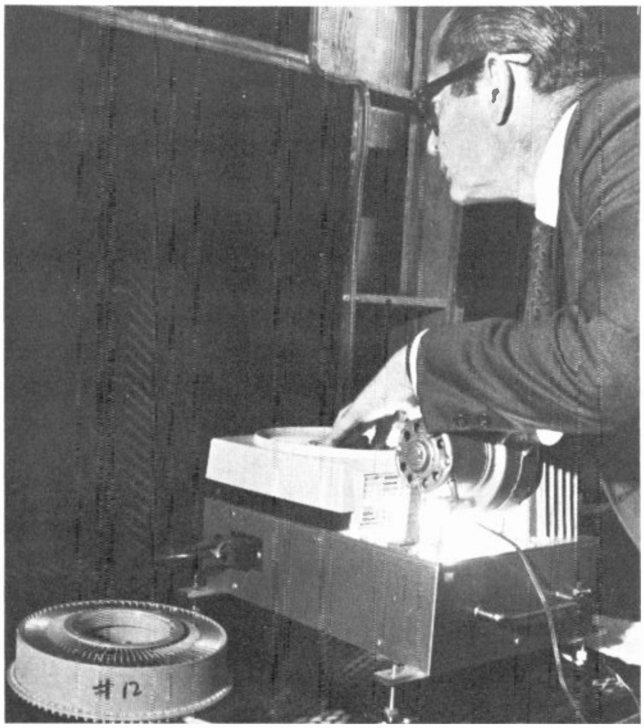


Figure 8. A projector modified by the addition of a Xenon Eight source. The added blower and projector are mounted on the remote of the power supply.

Figure 9. Technical director Stan Goldstein is shown adjusting the alignment of a projector with an SMPTE slide.



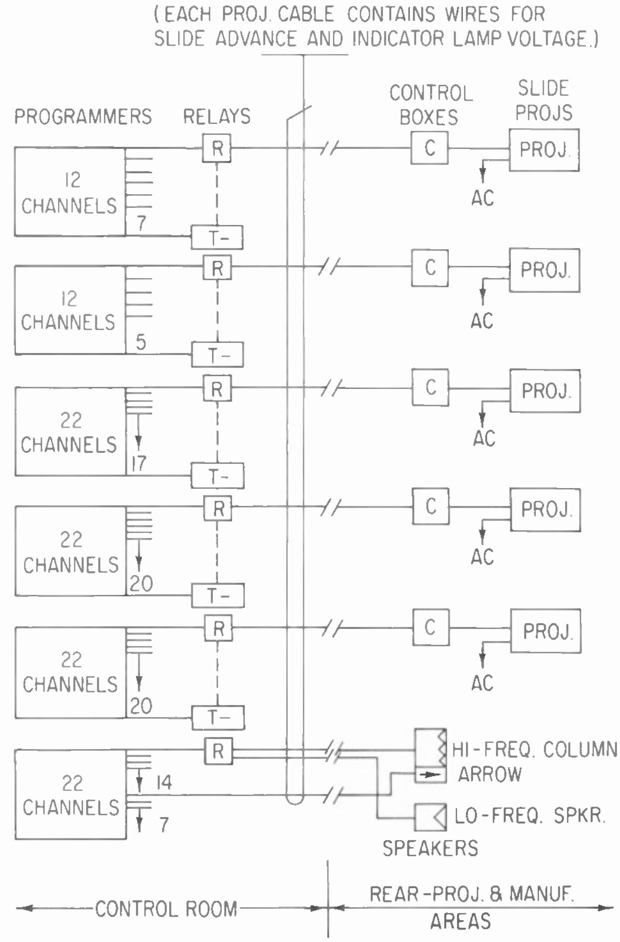
housed in six metal racks located in a small room adjacent to the rear-projection area. Two of the racks contain the six projection and sound distribution control programmers *(Figure 2)*. Behind the four programmers in one of the racks are the relays used in the projector and sound control system *(Figure 3)* including the larger T-Bar relays at the top of each of the rows of smaller relays. The hinged door on the other programmer rack has mounted on it indicator lamps *(Figure 4)* which show when a slide projector has lost its source of illumination.

The other four racks contain all the audio equipment *(Figure 5)* which originate and amplify the sound and music for all the display areas.

As the machines are quite large, and each working part of the unit created a different sound, it was decided to record the sound in two parts, one take for the operating sound and one for the motor or chain drive. The recordings, made by Frank Lewin of Demeter Music, Inc., were made with a directional microphone on a full-track Nagra at 7½ in./sec.

The tricky part came in the dubbing of the original single track sounds to two-track tape for use at the exhibit. The rhythm of each sound for each machine had to be matched carefully with the other half of the total audio of the working machine. In the playback, the high frequencies are fed to a sound column located close to the machine, and the lower frequencies are fed to a bass speaker hidden near the part of the machine which created that sound originally. The level of each sound is

Figure 10. A line diagram (simplified) showing typical projector, sound, and indicator-arrow control circuits.



balanced against the other so that the composite sound effect is as realistic as possible. In the projection portion of the exhibit, modern rock music written and recorded by Entermedia Futures, Inc. is distributed through flat response speakers as shown in *Figure 13*.

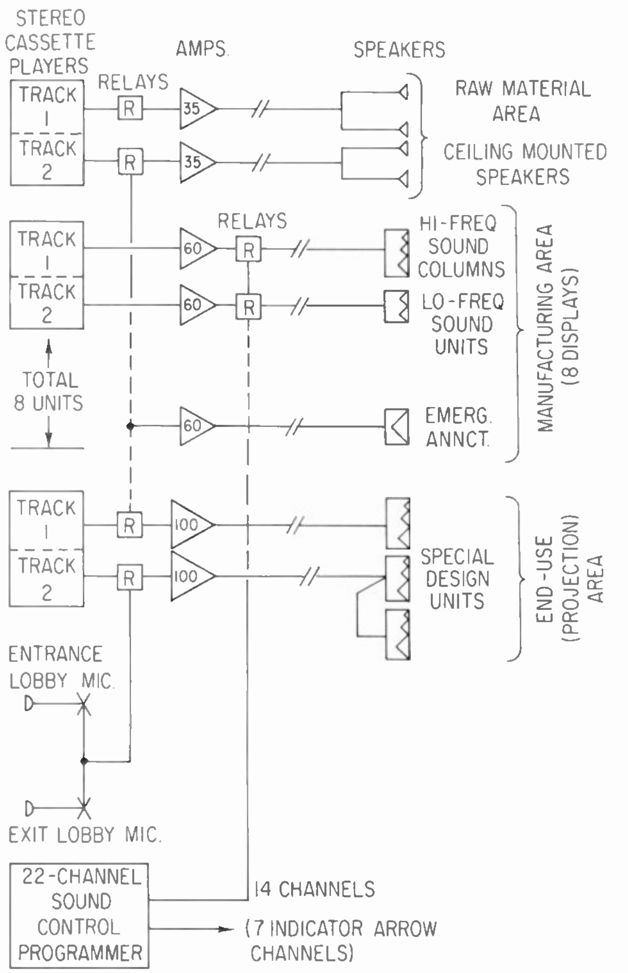
As in all public display areas, emergency precautions are required for the safety of the visitors, and, incidentally, to assist in preventing damage to any of the display items. For this purpose, a page system was installed with push-to-talk microphones in each of the lobbies. These use relays and the existing amplifiers in the first and third areas, and a separate amplifier and speaker in the machinery area.

Schools, church groups and other organizations are invited to schedule guided tours of the Mill. For this occasion, a wireless microphone system, with speakers overhead directly over the moving walkway, permit a guide to stand at the machinery and describe the operation of a typical mill.

It is Burlington's hope that they have provided the visitors to the exhibit with an entertaining and interesting display of how a mill works. Creation of good will, greater interest and closer association of the audience for the various subsidiaries and products of Burlington as well as a brighter aspect of the outside of a big business building on a busy side street are also among the desires of Burlington. The company that does more with fabrics than anyone else in the world has also created the latest and largest spectacle of its kind anywhere, and right in the center of fun city.

We wish to express thanks to Mr. Larry Carr of Burlington; Mr. Gene Demick of Bergen Expo Systems, audio-visual supplier and now maintaining the operation of the exhibit's a-v facilities; Mr. Bill Merrill of Porto-Vox Enterprises, Inc., audio and control equipment supplier; Mr. Bob Vogel, audio-visual engineer; Mr. Ron Gold of Rinzler/Arden Agency and the technical staff and guides of the Mill for their invaluable assistance. Photographs are by Burlington, Joseph Getzoff, and Leo Lowenthal.

Figure 11. Projector control and lamp indicator circuits typical of incandescent lamp slide projectors.



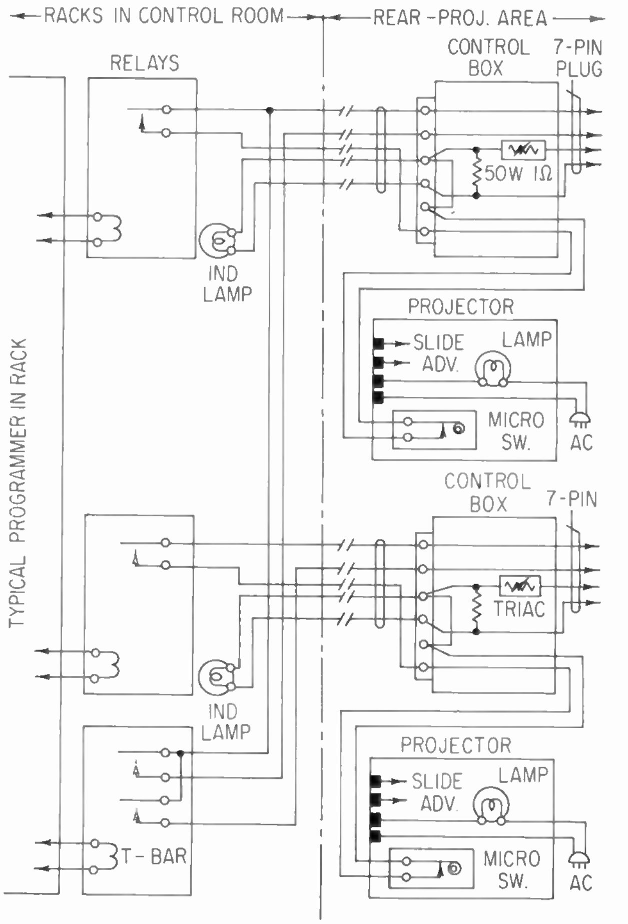
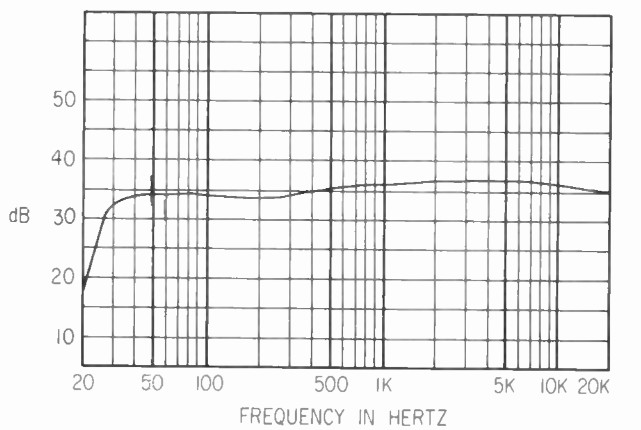


Figure 12. A simplified single-line diagram of the sound operating system. The wireless microphone system is not shown.

Figure 13. The frequency response in s.p.l. of the music speakers used.

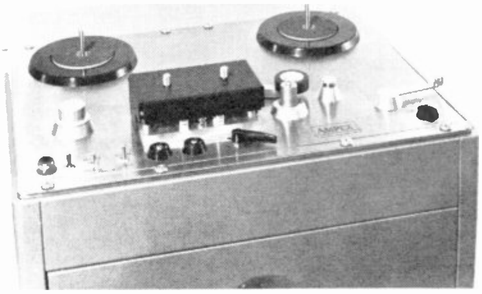


(continued from page 31)

AMPEX

Series 3200—Uses a flexible building-block principle. It starts with a master unit/console and one slave and is expandable to a maximum of ten slaves. The master uses tape on reels (no bin) which may be run backwards for no-rewind copies. Up to 14-inch reels can be used, ¼-inch tape, for duplicating full, half, or two-track mono tapes. Two-track and four-track stereo versions are available. *Circle 90 on Reader Service Card.*

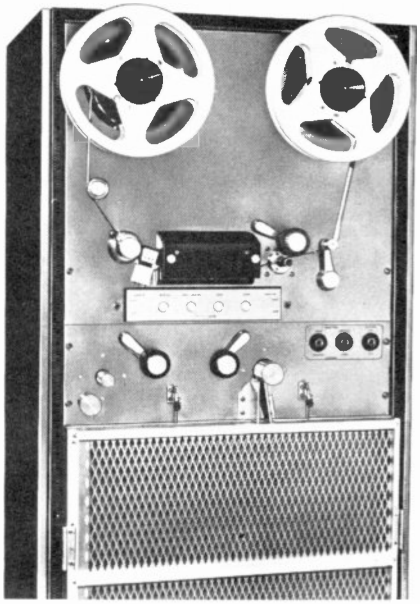
Series BML-200—is a high-speed duplicator system for multichannel cartridges, cassettes, and reels. The endless-loop bin master can drive ten to twenty slaves. These slaves are field-convertible between cartridge and cassette formats. The master takes eight tracks on 1-inch wide tape; the slaves will reproduce these eight on 250-mil wide (¼-in.) tape or 150-mil wide tape (cassette) with four tracks. The slaves tape 14-inch reels, while the master bin will hold 1200 feet (about 30 minutes playing time per program track. *Circle 91 on Reader Service Card.*



The Ampex BML-200's bin slopes and has a transparent front. Electronics are below, including a pump and the power supply. The slave unit deck can have guides and heads interchanged.

ELECTROSOUND

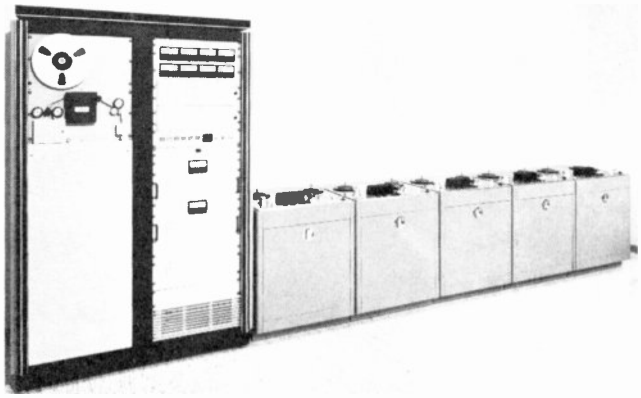
Series 4000. High speed duplication from a reel-type master and slave system that takes up to 14-inch reels on either master or slave transports. The masters also have a bin for endless-loop operation. Plug-in head assemblies facilitate the shift from cassette to cartridge duplication operation. A complete line of tape processing accessories is also available. *Circle 94 on Reader Service Card.*



The Electro Sound master's bin permits the tape to be seen.

VEGA ELECTRONICS

Model 5000—Continuous loop master (up to 1200 feet in the bin) uses 1-inch tape for four- or eight-track operation. Reels for storage can be up to 10 ½-inch in diameter. The slaves take ¼-inch tape for eight-track recording (cartridge) and 150-mil wide tape for four-track cassettes. Up to ten slaves may be ganged for operation. A special bin is available for up to 1800-foot master operation. *Circle 96 on Reader Service Card.*



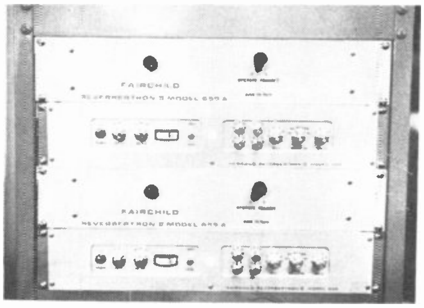
A Vega master, electronics rack, and five slaves. The tape-loop rack is below the transport, while the master electronics are in the adjoining rack.

Picture Gallery N.Y. AES Convention

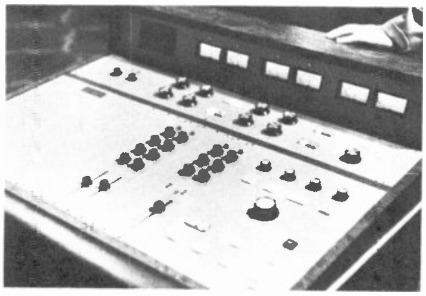
THIS AND THE FOLLOWING pages contain the new and almost new products found at the New York AES Convention's exhibition. The Hotel New Yorker was host to this largest convention between October 12th and the 15th.

Each photo is keyed with a reader service number. Simply circle the appropriate number(s) on the reader service card at the back of this issue and you will receive further information directly from the manufacturer.

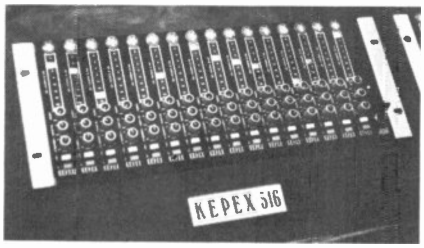
Audio Designs' RMC-1721 remote console is priced at $14,750. *Circle 76 on Reader Service Card.*



In a table-top rack, the **Fairchild** 659A Reverbertron II system. *Circle 73 on Reader Service Card.*



Westrex has a console that fully controls their Diskmaster mastering system. *Circle 75 on Reader Service Card.*



Kepex had a far-out demo booth in which they demonstrated their keyable program expander. *Circle 87 on Reader Service Card.*

Gately Electronics put this console together with their modules. *Circle 50 on Reader Service Card.*

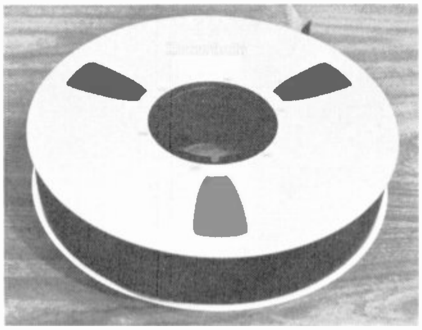
Suburban Sound components combine to form "instant consoles." *Circle 89 on Reader Service Card.*

This **Langevin** console has nine channels in and four out. *Circle 78 on Reader Service Card.*

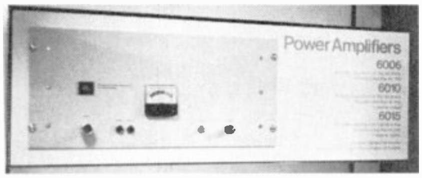
Quad-Eight came to the show with this new console. *Circle 85 on Reader Service Card.*

The **Spectra-Sonics** console has 20 channels in for 8 channels out. *Circle 88 on Reader Service Card.*

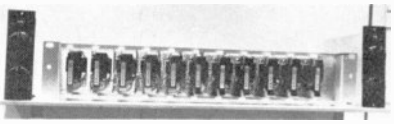
Electrodyne's most recent console has 16 channels in and 8 out. *Circle 86 on Reader Service Card.*



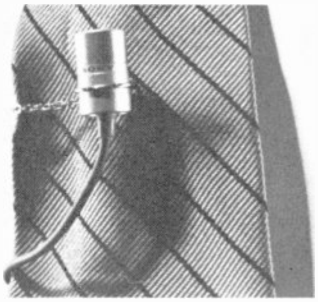
From **Scotch**, a new mastering tape, type 207 with improved characteristics of noise. *Circle 53 on Reader Service Card.*



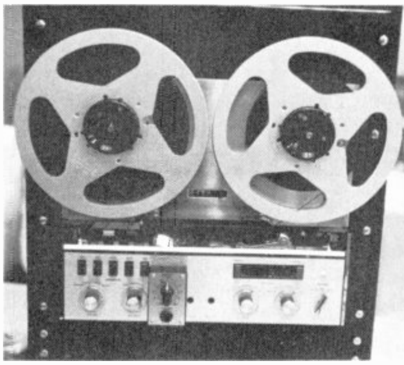
For sound reinforcement, **JBL** showed their model 6015 150-watt amplifier. *Circle 68 on Reader Service Card.*



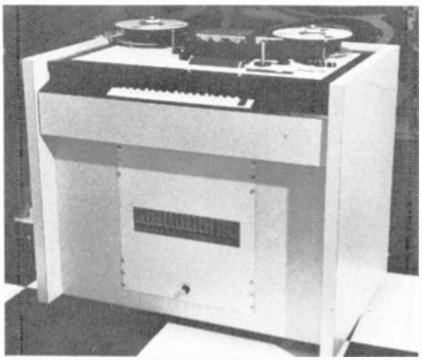
UREI had the model 1109 amp/preamp card unit among its many items. *Circle 70 on Reader Service Card.*



A tiny condenser microphone, **Sony-Superscope**'s ECM-50 tie-tack model. *Circle 61 on Reader Service Card.*



ReVox A-77 machines can now be ordered with plug-in adjustable drive speed control. *Circle 64 on Reader Service Card.*

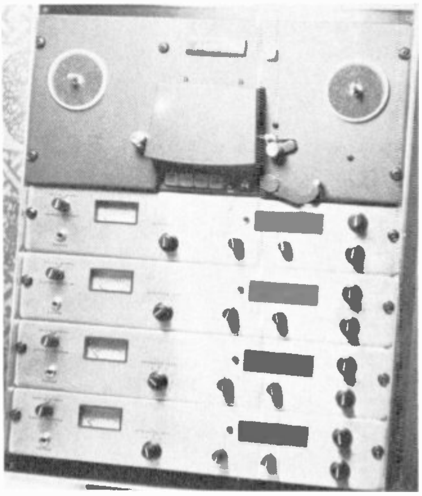


Scully—the new 16 track model 100-16, available for the low price of $13,750. *Circle 55 on Reader Service Card.*

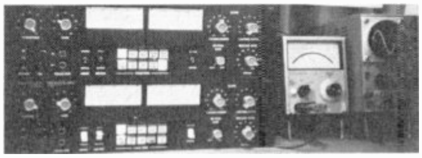
A first showing of the **Norelco** professional 3¾ in./sec. cassette recorder. *Circle 57 on Reader Service Card.*

The little battery-portable stereo **Stellavox** with big 10½-inch reel adapters. *Circle 79 on Reader Service Card.*

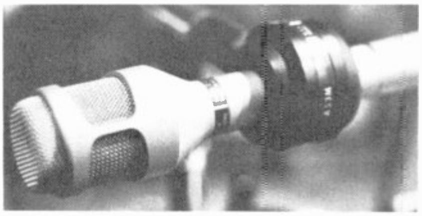
The new thin **Dolby** 360 tape noise suppression system fits between Scully modules. *Circle 52 on Reader Service Card.*



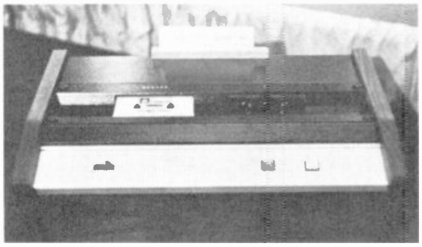
Four tracks on ¼-inch tape from **Ampex** on their new AG-500-4 model. *Circle 71 on Reader Service Card.*



Automated Processes showed a radically new limiter, compresser, expander system, model 500. *Circle 84 on Reader Service Card.*



Shure dramatically demonstrated the effectiveness of their isolation mounts for microphones. *Circle 58 on Reader Service Card.*



Pentagon showed the C120 system for cassette-to-cassette small-run duplicating. *Circle 74 on Reader Service Card.*

Caddco has a large variety of studio console accessories in plug-in configurations, "A Series." *Circle 81 on Reader Service Card.*

How do you pick up sound without noise?

Pick up the new RE50 and the new RE85 quiet microphones.

Model RE50 omnidirectional dynamic $120 list. Model RE85 lavalier dynamic $133 list. Less normal trade discounts.

Introducing two microphones that aren't "microphonic". That are unexcelled for hearing air-borne sounds, but shrug off contact noises. The new hand or stand RE50 and the lavalier RE85 dynamics.

Small, light, and just barely larger than the smallest microphones of their type. Yet both use a unique double-wall construction that is more effective in reducing microphone noise than any other we have tested.

Let's look into the RE50 first. A cutaway shows that inside each RE50 nestles the familiar 635A, case and all. It's shock-mounted at top and bottom to the outer case. Even the connector is isolated from the actual microphone. And the problems of mass and resonance have been worked out (with the aid of our computer) so that contact noises and cable rustling never reach the Acoustalloy* diaphragm.

The result is remarkable isolation from all but air-borne sound, even in hand-held applications where microphone movement is uncontrolled. And when you add the extra protection of the built-in Acousti-foam* blast and pop filter, this is one of the quietest omnidirectional microphones you can find. Yet response, output level, and polar pattern are essentially the same as the 635A (one of the most popular professional microphones of all time).

But if noise can be a problem with hand-held and stand microphones, it is a plague to lavalier types. Clothing rustle, cord noise, and accidental contact with hard surfaces are common troubles. Except with the new RE85. Again, we have created a microphone within a microphone. But we've gone even farther. A special low-noise grille, for instance. And even the hard, smooth paint finish was chosen to reduce small rubbing noises.

The result is virtually noise-free operation even with inexperienced performers. And at no expense to sound quality. Like all E-V lavaliers, output of the RE85 is peak-free and natural. Each RE85 comes complete with neck cord, tie clip, and a belt clip to help control the cable. The RE50 is supplied with a Model 300 stand clamp.

Both the RE50 and the RE85 are now available at your E-V microphone headquarters. In this noisy world, it's a relief to know that help has quietly arrived.

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PEOPLE, PLACES, HAPPENINGS

• Two announcements from **BASF Systems** tell of the opening of a new distribution center for the use of central warehousing and shipping. The location is their present Crosby Drive site in Bedford, Mass. The recently completed 40,000 square foot building features special air-conditioned storage for temperature sensitive tape, an office area, and six loading docks. The second announcement tells of the election of **Thomas Dempsey** as vice president of marketing and sales. Mr. Dempsey has been with BASF for the past six years. He was named marketing manager in 1969, after having served as national sales manager for BASF audio magnetic products.

• **Emanual Weintraub,** executive vice president of **Sterling Electronics** has announced that **Albert J. Marron** is the newly-appointed president of **Magnetic Windings Company** of Easton, Pa. The present president, **Bernard J. Beauregard,** is retiring. Mr. Marron brings to Magnetic Windings the experience of being the recent president and a director of **Hamilton Industries, Inc.** of Atlanta, Ga. Prior to this he was the general manager of **Teleflex.** Magnetic Windings manufactures electronic transformers and coils.

A new exchange visit of professionals in the audio/music field is now being organized for a May 1971 trip to the Soviet Union and other Eastern countries. The exact date of leaving is May 8th. You will visit these countries and meet your work counterparts. You will see studios and broadcast facilities that do things differently from your way. The sponsors of the trip are the **Citizens Exchange Corp.** (a non-profit, non-political organization). Co-sponsors are **db Magazine** and **Billboard.** It is expected that the Editor of db, columnist **John Woram,** and **Radcliff Joe** of Billboard will be along.

What does it cost? How long will it be? Present cost is established at $1068 which will be held until March 30th. This is an all-inclusive cost—air transport, hotels, meals, etc.—you will need very little pocket cash unless you are a souvenir grabber of large proportion. (It is anticipated that there will be a $100 increase in cost after March 30th—so it pays to subscribe early.) The duration of the trip, starting from New York, will be three weeks, with return to New York.

Write to the Editor for more details on this exciting Audio/Music Exchange Trip. Write: **The Editor, db Magazine, 980 Old Country Road, Plainview, N.Y. 11803.** Or you may contact the CEC directly at **10 West 46th Street, New York, N.Y. 10036.**

• **CCA Electronics Corp.** has purchased its present headquarters and manufacturing facility in Gloucester City, according to the announcement by **Bernard Wise,** CCA president. In his statement, Mr. Wise said that the purchase of the building increases the company's potential to 50,000 square feet of manufacturing, warehouse, and executive office space in a single, economic location. Heretofore, the company had been using only about half the building. In this facility, the company manufactures its complete line of professional broadcast transmitters. CCA also manufactures, through two subsidiaries—**QRK** and **Rek-O-Kut,** both in Fresno, California, amplifiers, tonearms, and turntables.

• **Ralph Gittleman** has been appointed vice president-commercial products at **Melcor Electronics Corp.,** a subsidiary of **Newton Electronic Systems, Inc.** In this new position he will be responsible for the Melcor line of professional broadcasting and recording studio components and new commercial products. Mr. Gittleman, a co-founder of Melcor, was previously vice president of marketing. Prior to founding Melcor he was computer section manager of the **Maxson Electronics Corp.** in New York. He also held various engineering positions with the **American Bosch Arma Corp.**

• **Carl Holder** has been appointed to the new position of new products development manager for **Audio Devices** according to an announcement from **William Goldstein,** v.-p. marketing and sales. In his new position, he will be responsible for the conception of new product development, from the exploration of new ideas, products, and applications—through technical development. He has been with Audio Devices for three years and was previously in research and development engineering. Prior to joining Audio Devices he was with **RCA** in their magnetic products division.

• At the recent meeting of the **National Council of Acoustic Consultants,** the following officers were elected: president—**Vincent Salmon** (Menlo Park, Calif.); vice-president—**Kenward S. Oliphant** (San Francisco, Calif.); secretary-treasurer—**O. L. Angevine, Jr.** (East Aurora, N. Y.). Three directors were also appointed. They are **Vincent D'Aprile** (Kingston, N. Y.); **Robert Lindahl** (Trenton, Mich.); and **Darial C. Fitzroy** (San Rafael, Calif.).

• **Robert D. Carrell** has been appointed director of **Superscope's** new tape duplicating division, according to **Joseph S. Tushinsky,** company president. Carrell will be responsible for organizing and managing the new facility located in San Fernando, California and will report directly to the president. The division's primary function will be to duplicate in all configurations the total output of Superscope's recording division. Special educational material and custom duplicating services are planned for a later date.

• **Peploe, Inc.** has announced the purchase of the **Janszen** speaker division from **Neshaminy Corporation.** The Minneapolis, Minnesota based electronics firm will continue and augment the speaker line, including the electrostatic elements found in most models. Peploe also owns **Electronic Industries, Inc.,** a firm in the music field; and **RTR Industries, Inc.** a westcoast speaker manufacturer. Peploe itself manufactures prototype printed circuitry and commercial airline products. Neshaminy Electronics will continue in its manufacture of components for the computer market.

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Or take the governmental agency that wanted an unfailingly reliable tape machine to register and record satellite bleeps. The choice? Revox.

Or the medical centers that use specially adapted A77's for electrocardiographic recording.

We could go on and on (see accompanying list), but by now you probably get the point.

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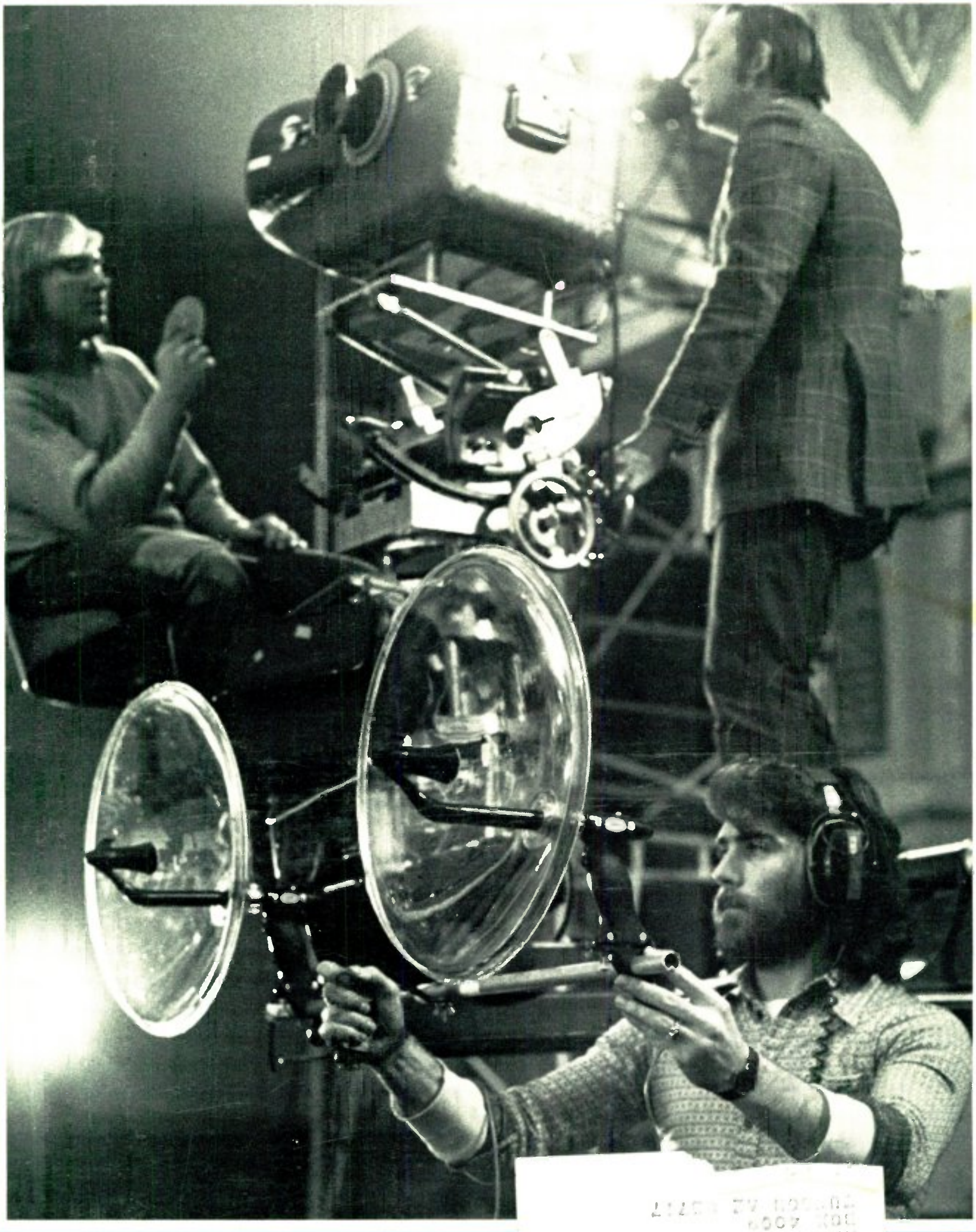

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16. Magnetic Recording. *Charles E. Lowman.* Reference guide to the technology of magnetic recorders used in audio recording, broadcast and closed-circuit TV, instrument recording, and computer data systems. Includes latest information on cassette and cartridge recorders; TV recorders; direct and FM signal electronics from low to wideband; servo-control and signal record/playback circuitry; capstan, reel, and head-drum servos for longitudinal, rotary, helical-scan, and disc recorders. Glossary, index, bibliographical information. 274. pp. **$14.50**

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39. Reference Data for Radio Engineers. *ITT Staff.* 5th Ed. The latest edition of one of the most popular reference books for radio and electronics engineers as well as libraries and schools. Complete, comprehensive reference material with tables, formulas, standards and circuit information. Contains 45 chapters, 1196 pages with hundreds of charts, nomographs, diagrams, curves, tables and illustrations. Covers new data on micro-miniature electronics, switching networks, quantum electronics, etc: **$20.00**

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• Equalization in Magnetic Recording describes a method used to evaluate recording non-linearity by means of modulation characteristic as well as data concerning amplitude distribution over the audio spectrum. It was written by a Bulgarian and originally appeared in a Russian publication. The author is M. Boyanova and the article has been translated by George Alexandrovich.

Short but interesting, describes James W. Burlingame's Almost Something-For-Nothing Power Supply. When you need a negative voltage when only a positive 12 V car battery exists, you will be glad to have saved this circuit.

What happens to balances when a live symphony orchestra must be combined with magnetic tape sound and other electronic effects? Stephen H. Lampen has the answer, at least insofar as a performance of the San Francisco Symphony is concerned, in Amplifying an Orchestra.

And there will be our regular columnists: Norman H. Crowhurst, Martin Dickstein, and John Woram. Coming in **db, The Sound Engineering Magazine.**

ABOUT THE COVER

• The parabolic mic has been around for a long time but it is only now coming into its own as a serious recording tool. Here are two in field use, a function they serve well.

db

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letters

The Editor:

In two recent advertisements[1,2] in your magazine, statements are made in regard to multi-pattern microphones which may be misleading to some readers. Under the heading, *The Truth About Patterns* is the following: "It is true that all of the switchable characteristic microphones also have an omni-directional pattern position, but it is formed through the electrical combination of two cardioids and therefore largely behaves like a directional microphone."

While the statement may reflect undesirable properties of some multi-pattern microphones, the limitations cited are certainly not true for all multi-pattern microphones. Those microphones in which the omni-directional pattern ". . . largely behaves like a directional microphone" are manufactured after the design disclosed in the Grosskopf patent.[3] In this design, the pattern change is achieved by the electrical switching (phasing) of two cardioids. The system has been described by Bauch[4] and Eargle.[5]

The condenser microphones manufactured under the Shoeps patents[6] do

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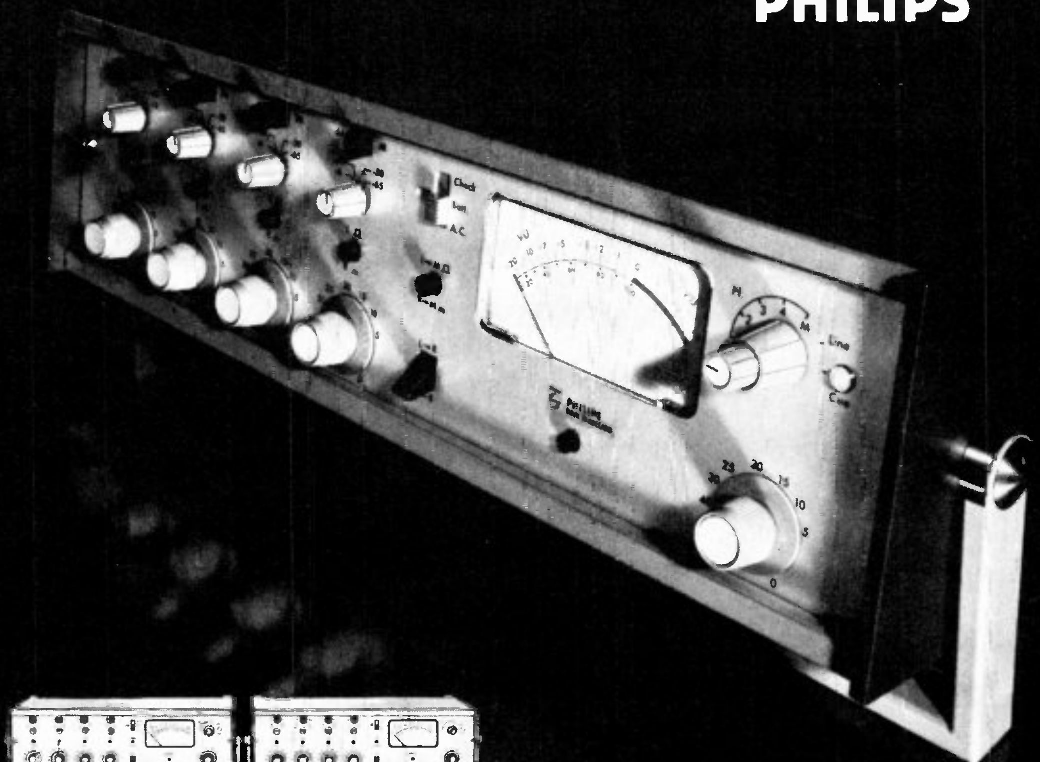

not have these limitations. In the Schoeps microphones, not only does one have the advantage of acoustically pure cardioid and figure-eight patterns, but also the advantage that the omni-directional pattern is a pure pressure transducer and is therefore ". . . completely free of the proximity effects such as popping, low end boost, and high-end edginess . . ." associated with the pressure-gradient transducers. The principal on which the Schoeps microphones change patterns is the mechanical switching of the acoustical chambers behind the diaphragm. The capsule is basically a pure pressure omni which is modified to a cardioid and to a figure eight. Both of the Schoeps patents describe methods by which these acoustical pattern changes can be achieved by electrical switching.

REFERENCES:

1. **db Magazine**—December, 1973, p. 6.
2. **db Magazine**—January, 1974, p. 6.
3. H. Grosskopf—U.S. Patent #2678967, assigned to Nordwestdeutscher Rundfunk, Hamburg, Germany
4. Bauch, F. W. O.—"New High-Grade Condenser Microphones," **J.A.E.S.**, Vol. 1, No. 3, July, 1953.
5. Eargle, J.—"How Capacitor Mics Produce Cardioid Patterns," **db Magazine**, April, 1971.
6. K. Schoeps, Willy Kusters—U.S. Patent Nos. 2852620, 3190972, Karlsruhe-Durlach, Germany.

Albert B. Grundy
Director, Institute of Audio Research
New York, N.Y.

Response by Stephen F. Temmer, president of Gotham Audio Corporation.

The ads referred to were all about Neumann microphones and were strictly directed toward helping Neumann clients to select the proper model from among our twelve different ones. While Mr. Grundy's remarks about the microphones which he had represented for some years are true, we had never really felt that the word *switchable* referred to the positioning of a mechanical lever. We will in future use the adjective *electrically switchable* to avoid confusion.

It might also be interesting to note that the mechanically switchable pattern capsule was also invented by the same Mr. H. Grosskopf of the Institute for Broadcast Technology (I.R.T.) under U.S. Patent #2,787,671, who also invented the electrically switchable directional pattern. The Grosskopf patent referred to above was assigned to Schoeps, while the electrically switchable patent (2,678,967) was reassigned to Neumann by NWDR. The Kusters patent referred to by Mr. Grundy outlined only design and operating improvements on the basic Grosskopf patent.

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John M. Woram

THE SYNC TRACK

• Lately, there has been a series of letters asking for information on setting up small studios. One person inquired about books that discuss in depth the subject of building a small studio and, are there any companies that cater to the small studio population?

Well, there are no books, that I know of, on *How to Build a Small Studio*, or even, *How to Build a Large Studio* for that matter. Unfortunately, building a studio is not as clear cut as adding an outdoor patio or putting up a dormer in the attic. So, although there are published instructions for patio or dormer, no one—so far—has come up with studio plans.

Probably no one ever will. Or if they do, the book should be regarded with as much suspicion as the one that tells you how to mic drums. (see June *Sync Track*). Studio planning, and construction, depends on too many variables to be treated in text book format. Of course, general acoustic principles have been well covered in several texts (see February *Sync Track*), but the application of these principles to your studio cannot come from a book. Your personal requirements, and budget, will greatly influence the construction of your studio, and if you are unsure how to proceed, you should call in outside help before going ahead.

As for companies that cater to the small studio, there are of course many manufacturers of small consoles who may be consulted. When it comes to other equipment—microphones, speakers, signal processing devices, etc., the difference between small and large studios is primarily one of quantity, although the small operation may have to make do with more general-purpose type of gear, and leave the specialty items until later.

Naturally, the dealer would prefer a large account to a small one. Since the small studio population doesn't buy much, perhaps it doesn't get the attentive catering it needs. It's ironic, I suppose. The big time studio will have an experienced chief engineer who knows the business thoroughly. (Or at least he thinks he does). He doesn't need anyone's help or advice in choosing, and purchasing, equipment. Yet he gets more attention than he can stand because the supplier knows he's a "big spender." Down the block, the small studio operator who *needs* help can't get the time of day from his supplier because his account isn't worth the bother. I have many poignant memories of trying to get help in solving studio problems. Unless there was a definite possibility of a lot of money changing hands, I was strictly on my own.

Before all those wonderful "mom and pop" small guy-oriented shops start coming out of the woodwork and writing angry letters, let me point out that there is definitely another side to this coin.

Since getting involved in the consulting racket, I've gotten periodically depressed by the number of would-be small studio operators who are looking for free advice, wherever they can get it. Then, after they've gotten it, it's off to the nearest bargain basement discount house to buy their equipment. I suspect that the response I get to my ad is fairly typical of anyone in the same type of business. Via mail and phone come the inquiries: How do I do this or that? What kind of console do I need? What microphones

do I need? And on and on. Well of course I don't want to turn this kind of response off, but since I don't sell equipment directly, it would be very easy to go "down the tube" dispensing free information to all. So-o o, we turn delicately to the subject of $$$. A "consultation fee" it's called, and it is one of the most effective ways known to stop a conversation. The idea of paying for a service is just too much to bear. (Fortunately, not everyone feels this way, or I'd really be in trouble).

But anyway, you get the idea maybe? These same people will go out and bargain shop—going from store to store looking for the cheapest price they can get. I encourage my bride to do this—at the supermarket. If tomatoes are cheaper at the other store, she gets them there. And so on, down the grocery list. The economic advantages are obvious, but it is strictly up to my lady to find, and bring home, the bargains. Once she leaves the store the owner's interest vanishes. He knows damn well she will not be back unless his potatoes are on sale. And later on, if some of the food doesn't cook well, *he* certainly doesn't want to hear about it.

Now, if we can find our way out of the kitchen and back to the studio, what do you suppose happens when this bargain basement approach is tried when putting a small studio together? I'm talking, of course, to the point of view of the man who needs professional assistance.

What else? You wind up with a lot of problems. And, when you complain that the limiter won't limit, the dealer tells you it must be because of the console you bought (from a different dealer, naturally). And the console man blames it on the studio wiring job, which was done by the local high school shop class as a term project.

In short, nobody wants to know about your problems. And for good reasons too. Even if your limiter salesman was Mr. Sincere, he couldn't possibly figure out the mess in which his limiter has been placed. He knows that if he comes around to help, he's going to wind up inheriting all your other problems too, since he can't verify the limiter's performance if the rest of the system isn't working properly.

Where is all this leading?

If you're looking for a book on studio planning, it's because you don't feel qualified to tackle the job on your own. But—to continue the June discussion on books—you can't expect a book to do your planning for you. If you need help, get it. I presume the various letter writers need help, otherwise they wouldn't have written.

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In response to the increasingly complex needs of the audio community, the industry standard Model 550A, perhaps the most popular equalizer in the world, is now joined by a group of new devices providing extraordinary flexibility.

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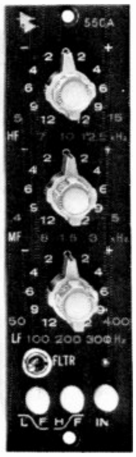
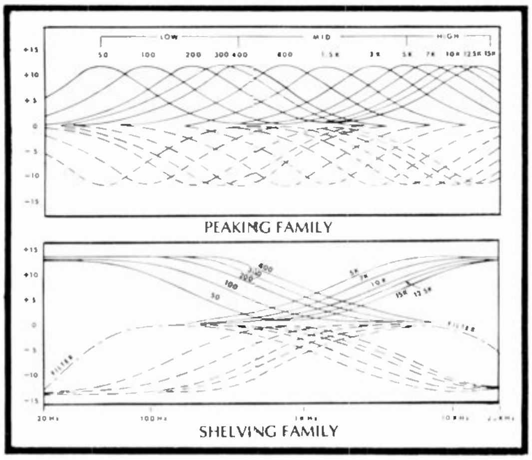


Concentric High, Mid, and Low frequency range switches allow a choice of 15 center frequencies with up to 12 dB boost or cut in each range. Additional switches provide independently selectable low and high frequency bell or shelf curves, band-pass filter, and in-out function with indicator light.



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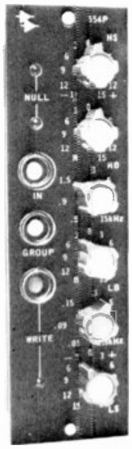
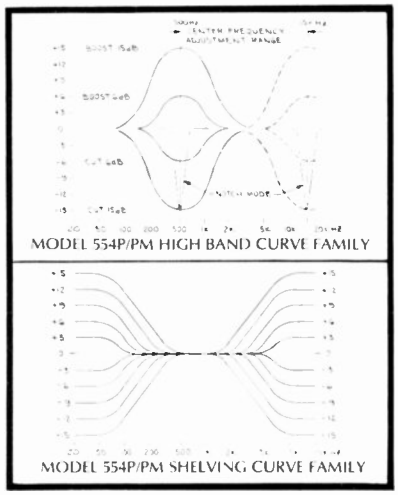


Dual Parametric manual and automated, continuously variable reciprocal peaking curves to a maximum of 15 dB boost or attenuation. A narrow "Q" notch is also provided, as are reciprocal shelving curves. The Model 554P provides flexibility and versatility consistent with the most advanced automated and manual audio mixing systems.



MODEL 554P/PM HIGH BAND CURVE FAMILY

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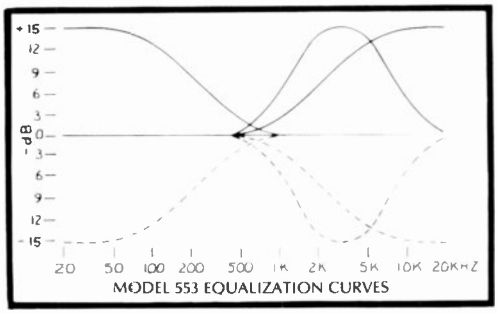
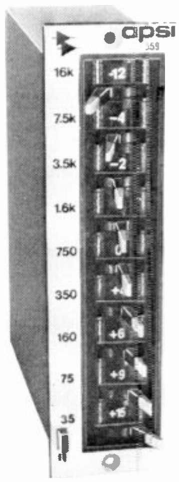
NEW-MODEL 553

A low cost, modular Equalizer suitable for a wide variety of applications in broadcasting, recording, film mixing, and sound reinforcement installations. The shelving type low and high frequency families of curves produce familiar overall balance changes in the musical spectrum. The 3 kHz mid-frequency peaking curves specifically affect the "presence" range of music and dialogue.

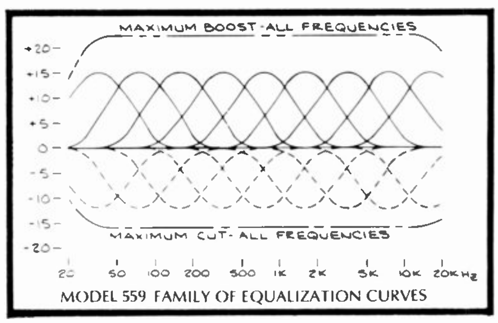


MODEL 553 EQUALIZATION CURVES

NEW-APSI MODEL 559



Simultaneous equalization in nine bands distributed over the three decades of the audio spectrum, with band centers at 35 Hz, 75 Hz, 160 Hz, 350 Hz, 750 Hz, 1600 Hz, 3500 Hz, 7500 Hz, and 16 kHz. Each band is controlled by a lever switch with an amplitude readout and provides reciprocal cut and boost of 2, 4, 6, 9, and 12 dB from unity gain and an additional 15 dB boost position.



MODEL 559 FAMILY OF EQUALIZATION CURVES

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What kind of help is available? Well, if you go to a responsible dealer, he'll be able to help you plan your purchases wisely. Don't be surprised though if he only recommends brands that he himself carries.

An independent consultant can be more unbiased in helping you, since he has no sales obligations, and can therefore recommend the equipment you need, and not what any one dealer would like to sell. But, he will expect to be compensated for his service, and if you can't face that prospect, a consultant is not for you.

Some dealers like to call themselves consultants. Some even keep a straight face while doing so. But as long as you're not being charged for the "consultation" you can humor him along. If he wants to charge you for telling you what to buy from him, beat it to the nearest exit.

Of course, if you need help much beyond planning what equipment to buy, then your dealer may ask to be compensated for additional services rendered. Which brings up an interesting point: how much service can you expect from your dealer in return for your business?

Historians tell us that many years ago, dealers would buy equipment wholesale, and resell it at retail. The dealer would make a profit, and would be genuinely glad to see you, since he valued all customers. Then something happened. Who knows where it started, but people started looking for discounts, not for quantity purchases, but just for the privilege of having the customer's business. As the discount syndrome took hold, store keepers searched for ways to cut corners, and one of the first things to go was service. Now, you walk in, haggle the price down as low as you can, and walk out with a "bargain." If you have trouble later, you know what you can do about it? Probably nothing—but you got what you paid for, didn't you?

Now, what with tight money and all that, some dealers are rethinking their discount policies. Some few companies have fanatically held to their list prices, and dealers who discounted have lost that company's product line. Although I haven't made a study of the subject, it seems no coincidence that these companies usually offer conspicuously better service too.

So, if you need help in planning your studio, never mind the bargain hunting. Find someone with the expertise to help you, and don't have a coronary if you are asked to pay for that help. If you go to a dealer who offers bargain basement prices, make sure your eyes are wide open, and find out in advance what sort of service to expect. If you know exactly what you're doing, then shop around for the best price, but don't expect attentive service later on. If you are not sure of your needs, or if you will require continuing help in getting your studio together, keep this in mind before spending your money.

As Julius Caesar said, "Caveat emptor!" (Or was it Orange Julius?)

COMING EVENTS

The 49th Audio Engineering Society Convention and Exhibition begins on September 9 and continues through September 12th in Fun City's plush Waldorf Astoria Hotel. There are details elsewhere in this issue on exact dates and times, but I want to draw your attention to four Educational Seminars that will be held during the Convention. These will be discussion groups by panels and not lectures. The four titles are 1. Introduction to Computer Programming, 2. Applications of the Desk Top Computer to Audio, 3. Tape Recorder Equalization, and 4. Practical Acoustics.

I want to emphasize the *practical* nature of these seminars. They should be of great value to working engineers attending the Convention. ■

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Norman H. Crowhurst

THEORY AND PRACTICE

• A curious fact about this column, which alternates between discussions of education and the technical matters that really should be its business, and are the business of **db**, is that the content of my mail is usually based on my educational columns rather than those concerned with technical matters. And most of the comments are favorable. So **db**, the sound engineering magazine, has provided a platform for views that are not often expressed in the several hundred vehicles ostensibly devoted to educational material, but which too often subscribe to the apparently universal compulsion that professional educators share, to impress both their colleagues and the rest of the world with their erudition rather than their understanding of what is actually going on.

But this month we are going to discuss technical business. In an earlier column, we stated the difference between the kinds of distortion that the SMPE (now SMPTE) and CCIF methods were designed to measure. The SMPE method was designed to measure the kind of distortion that happens when large amplitude, low frequency waves change the gain, or amplification, offered to higher frequency, smaller amplitude waves, thus modulating them.

Back in the days when the method of measurement was devised, feedback was just about finding its way on the scene. It was so new that little theory about it had been published, and those who worked on the kind of distortion SMPE was then interested in were pursuing a different line of investigation from those who worked on feedback.

So, in that context, the main cause of that kind of distortion was the variation in gain that modulated the amplitude of the higher frequency components, at the point of the low frequency high amplitude wave. If there was any accompanying phase modulation, it was of no consequence, relatively speaking.

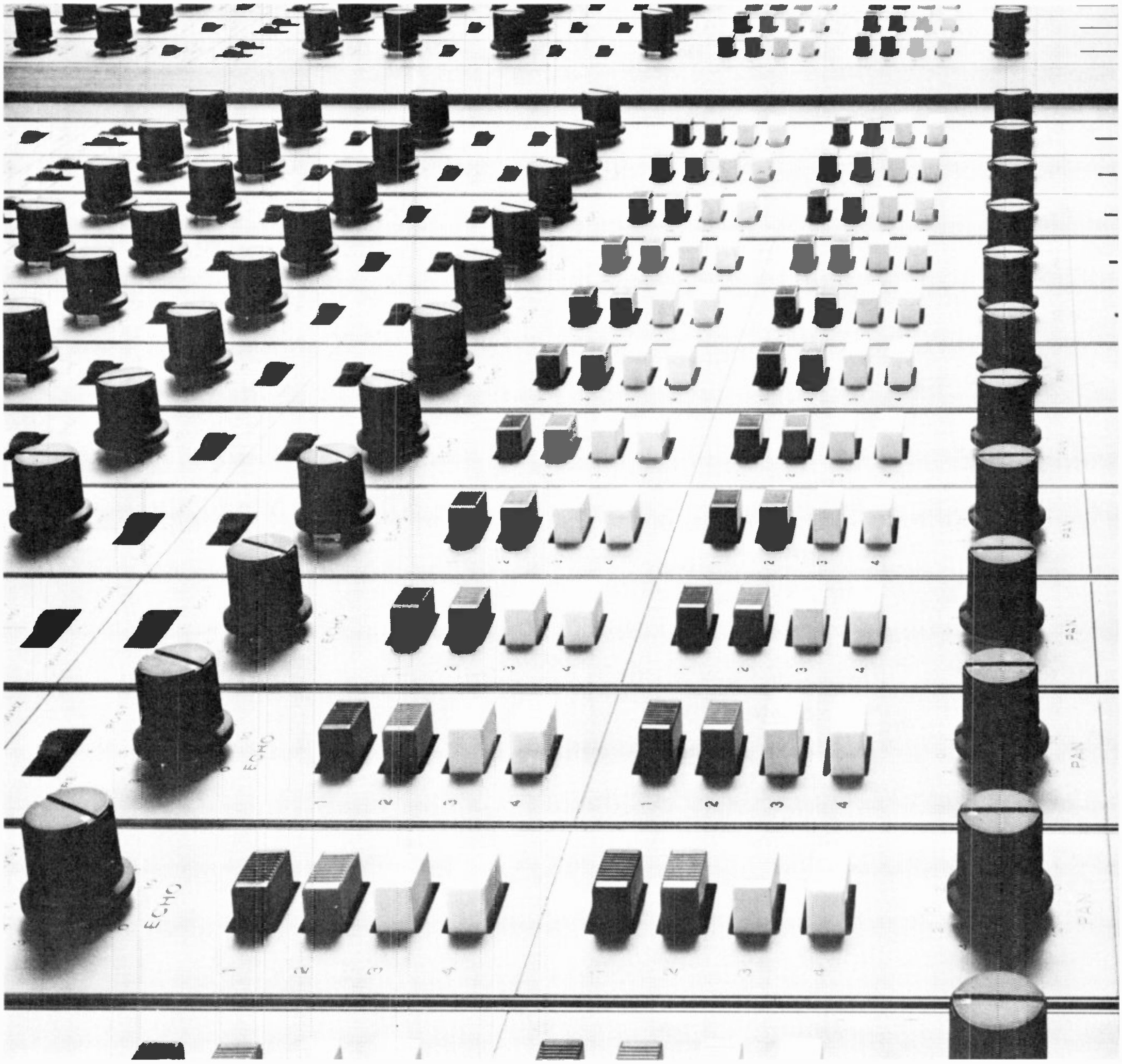
As everyone knows by now, one of the basic purposes of feedback is to reduce distortion, which includes the SMPTF type, along with everything else that qualifies as distortion. And as most people know, to apply feedback at all, phase shifts must be kept small; feedback will reduce them to something even smaller.

However, something that has been overlooked, the fact that feedback can produce SMPTE type intermodulation distortion, of the phase modulated variety. Over different parts, particularly of a large amplitude waveform, the dynamic resistance (also known as a.c. resistance) of active elements, whether they be tubes or transistors, changes over quite a wide range even when, as far as waveform is concerned, they are behaving linearly.

Perhaps I should explain that. When a tube or transistor is nearly cut off, its plate or collector resistance is many times the value it has at a moment when it approaches saturation. However, the voltages and currents associated with the waveform it amplifies may be very close to linear while this change in a.c. resistance occurs.

All these a.c. resistance values are associated with circuit reactances, either coupling capacitors, or stray circuit capacitance. And reactances produce phase shifts in the circuits where they are. When the resistance values change, the phase shifts change, although the waveform associated may not be distorted in any way. Such phase shifts that accompany the low frequency, high amplitude wave that produces the big swing will occur at any higher frequencies the same equipment is momentarily handling.

Now let's put it together. We may think that only amplitude modulation really matters. But this is not true. Consider a classic example, the difference between tremolo and vibrato.



Now I'd better be careful because people from different backgrounds have different definitions for these musical qualities. The predominantly engineering definition, which I am using here, expresses *tremolo* as a fluctuation in amplitude, while *vibrato* is a fluctuation in frequency.

Now, as is done by organ manufacturers all the time in the ranks of stops they group together as celeste, this kind of effect can be produced by using two ranks of pipes, or signal generators, each having a slight difference in tuning, so they produce a beat.

Imagine the composite sound produced by two frequencies close together, like organ pipes, coming from a loudspeaker which radiates into free space, so you are not troubled with standing waves to complicate matters. Because you have two frequencies, you will have two corresponding wavelengths, which means that at no two points in space will the same combination occur as you vary your distance from the source.

For this reason, at some points the result will be almost pure amplitude fluctuation while at others it will be almost pure phase, or equivalent frequency fluctuation. This is why you have such a hard time telling the difference between tremolo and vibrato. While each can produce its own effect to an extent that makes it not convertible into the other, they often seem to become equivalent to each other at certain points out in space where you do your listening.

From the causative point of view, of course, there are differences. If you use a variable gain stage to modulate the audio, the basic effect has to be tremolo. If you feed the audio to a loudspeaker that is somehow waved around in space, the basic effect has to be vibrato. And of course, the effect that Paul Klipsch has done so much to expose, as a deficiency of small-diaphragm wide-range speakers that he calls *doppler* distortion, is an unwanted frequency or phase modulation.

The point we started out to make here is that the SMPTE method does not, basically, detect that variety, although its effect on what you hear can be precisely similar to the variety the SMPTE method can detect. This is because the method of measurement consists of mixing the two frequencies together, a large low one with a small high one, feeding it through the equipment to be measured, and then analyzing the output in the following way.

First it goes through a high pass filter, that removes the low frequency component. Then the remaining high

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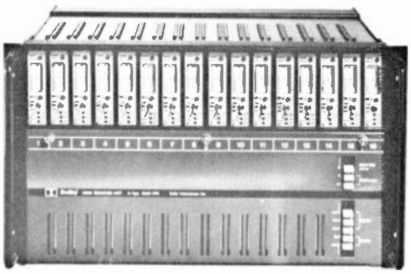
Professional Recording and Transmission Applications

360
The Dolby 360 is a basic single-channel A-type noise reduction unit for encoding or decoding. This unit is normally used in a fixed mode such as in disc cutting or landline sending or receiving; the operating mode is manually selected.

361
The Dolby 361 is similar to the 360, providing a single channel of A-type noise reduction, but with relay switching of operating mode and tape recorder connections. The changeover can be controlled automatically by the recorder.



M-Series
The Dolby M16 A-type unit is designed specifically for professional multi-track recording, and incorporates 16 channels of noise reduction in a compact chassis only 10½ inches high. The similar M8 is an 8-track version, and the M8X allows simple extension of the M16 for 24-track use.

Motion Picture Industry

364
The Dolby 364 Cinema Noise Reduction Unit is intended primarily for use with Dolby A-type encoded optical sound-tracks. The 364 also includes a standard 'Academy' filter for conventional tracks, a clean-up circuit for old or worn prints, and provision for playback of magnetic sound-tracks with or without Dolby system encoding.

E2
The Dolby E2 Cinema Equalizer is a companion unit to the 364, and has been specifically designed to solve the response equalization problems of cinemas. Used with the 364 and Dolbyized optical sound-tracks, the E2 enables most cinemas to achieve modern sound reproduction standards without replacement of existing equipment.

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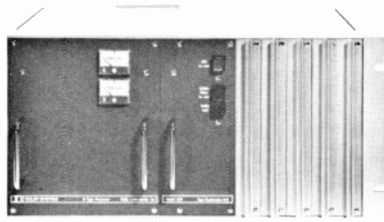
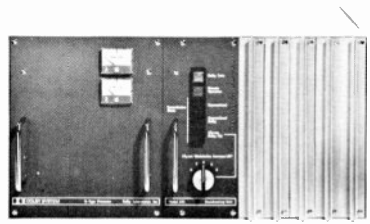


320
The Dolby 320 Duplication Processor is a professional quality unit with B-type (consumer) noise reduction characteristics. The unit is used for encoding duplication master tapes in the high-speed duplication of Dolbyized cassettes, cartridges, and open-reel tapes. The 320 is a two-channel unit.



324
The 324 Broadcast Encoder allows broadcast stations to encode stereo FM broadcasts with the Dolby B-type characteristic. The unit provides for an optional reduction of high frequency pre-emphasis, reducing the need for high frequency compression, and thus allowing a significant additional improvement of reception quality.

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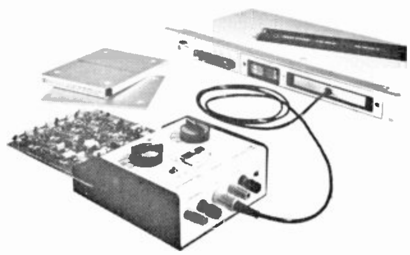

Cat 35
The Dolby NRM Test Set, Cat 35, permits rapid verification of performance of Cat 22 Noise Reduction Modules without their removal or the need for additional test equipment.

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frequency component is rectified and filtered to find whether its amplitude has any low frequency fluctuation. What this does not do is to determine whether its frequency or phase fluctuates. The rectification and filtering could not care whether frequency changes or not.

Before passing to the CCIF method and its deficiencies in measurement, we need to show that the two forms do not measure equivalent forms of distortion. The fact we mentioned a little earlier, that two higher frequencies close together are used to produce the celeste effect, as well as other beat effects, has led many to believe that the higher notes produce a lower note.

This is not true. The beat is not itself a note. In the first place, the beat is too slow to be audible as a note. But if you increase the difference between the frequencies, so the difference could be a note, it is not, as long as there is no distortion present, able to produce the CCIF type of byproduct.

The big difference is in cause and effect. With the SMPTE method, we start with a low frequency and a high frequency. The equipment must handle both. If, in doing so, one affects the other, you have SMPTE distortion. With the CCIF method, we start with two high frequencies. For this purpose, the equipment need not even handle the low, distortion-product frequency. So if you applied the SMPTE test to it, nothing would show, because the low frequency would not even enter the system.

The CCIF method produces the low frequency as a distortion product, that should not be there, and was not present in the input.

Now let us take a closer look at the CCIF variety of distortion. Suppose the two frequencies are 5000 Hz and 5100 Hz. If the system has asymmetric distortion, such as is due to an unbalanced push-pull stage somewhere, then the beat produced by these two frequencies, at 100 Hz, will have bigger tops than bottoms on the wave envelope produced. This will mean that, as well as the 100 Hz modulation envelope of the high frequency waves, there will be a 100 Hz component in the signal. This will appear, audible, as a 100 Hz "buzz."

That is what the CCIF method is designed to detect. But now, suppose the distortion is not asymmetrical, but symmetrical. Now the envelope will have its shape either flattened at top and bottom or stretched at top and bottom. It is not so easy to see what the additional byproducts will be in this case as it was with the asymmetrical case. But mathematical analysis shows that this is equivalent to a whole new bag of extra frequencies, none of which will be anywhere nearly as low as a few hundred Hz.

By a different choice of test frequencies, you can deliberately produce byproducts wherever you want, and the test can perform more like a waveform analyzer does in taking harmonic distortion apart. But to date, to our knowledge, no such method of measurement has been formalized. So all the CCIF method really detects is the kind of unbalance in a system that produces first-order, asymmetric distortion.

One of my recent correspondents reversed the usual way in which I transfer things, which is to show that what happens in education is like what happens among audio engineers. I had said, in a column I write for general audience readership, that the reason professional educators clamp down on anyone who attempts to say something unconventional, is that they are afraid if they allow it, the teachers will soon be out of their depth.

This man's comment said that he has found the same thing in engineering circles. That any suggestion that breaks with established convention makes engineers nervous too, because they feel they will soon be out of their depth. You know, I think he's right. Why else hasn't someone developed more sophisticated tests, so that distortion can be more exactly analyzed, more easily?

Probably because most engineers who use existing methods, do not really know what those measurements tell them, and if anyone suggests using a more sophisticated kind of test, with which they are unfamiliar, they fear they will soon be confused.

My attitude through life has always been to accept something strange as a challenge, not to reject it out of hand. I want to find out how it relates to what I already know, or think I know. And invariably accepting of the challenge leads to better understanding of something I would not have expected. Why do so many of us go around with mental blinkers on, afraid we might discover something useful? ■

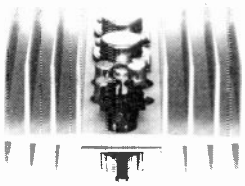
Circle 15 on Reader Service Card

NEW PRODUCTS AND SERVICES

FOUR-WAY MONITOR

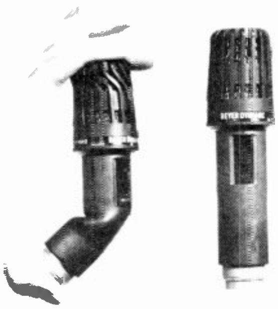
● Model 4340/41 four-way monitor is designed for bi-amplification use with the manufacturer's 5231/32 electronic crossover or with high level passive crossover networks. The system contains a fifteen-inch low frequency loudspeaker, ten-inch midrange loudspeaker, high frequency compression driver, and ultra high frequency compression driver, and has a frequency response of 35 to 20,000 Hz +3 dB. Sensitivity (SPL at 30 ft., 1 mW) is 44 dB. Power output (SPL at 10 ft. in a room volume of 2,000 cu. ft. with 1/.2 rated power input, 35.5 watts), is 101 dB. The crossover frequency is 250, 1,250 and 9,500 Hz.
Mfr: James B. Lansing Sound, Inc.
Circle 48 on Reader Service Card

OPERATIONAL POWER AMPLIFIER



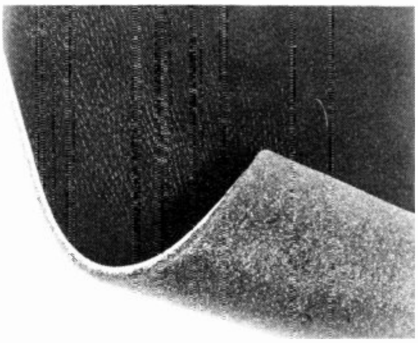
● Intended to be used as a servo motor or d.c. through audio power amplifier, model 440 differential d.c. operational power amplifier consists of an Opamp 4009 driving a dual class AB power amplifier. The manufacturer claims there is no crossover distortion. The unit may be used in audio applications with either a single polarity or bi-polar power supply. It has an output capability of 50 watts rms and is constructed on the octal plug-in heat sink, with the circuitry isolated from the case. Available either as a kit or wired and tested.
Mfr: Opamp Labs, Inc.
Price: Kit: $35; Wired & Tested: $60.00
Circle 49 on Reader Service Card

DYNAMIC SAFETY MICROPHONE



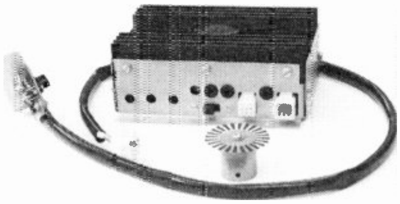
● Flexible rubber housing offers maximum security for dynamic unidirectional moving coil microphone M412, a feature of interest for field use. The microphone has a tailored acoustical characteristic especially suitable for close talking and can be gooseneck mounted or hand held. It has a built-in switch for voice on/off or for relay actuation. The frequency response is 200-12,000 Hz.
Mfr: Revox (Beyer-Dynamic)
Price: $75
Circle 50 on Reader Service Card

SOUND ABSORBER & VIBRATION ISOLATOR



● Sound barrier Soundmat FV is composed of a one-pound per square foot of limp mass, acting as the barrier layer, which is bonded to ¼ inch layer of acoustic foam. The acoustic foam is fire retardant. The material can be applied to floors or around resonating pipes by die-cutting and shaping to fit. For exposed areas, a heavy black vinyl skin can be laminated to the barrier, providing a scuff-resistant, water-barrier surface.
Mfr: Soundcoat
Circle 53 on Reader Service Card

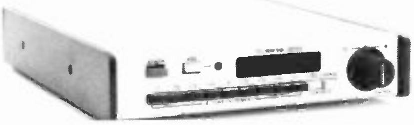
TAPE CONTROL



● Constant tension from beginning to end of any size tape reel is achieved by controlling the torque of the supply reel motor by the Tentrol controller. The device eliminates tape speed changes, and thus changes in pitch, with tape reels up to 14 inches. An additional unit can be installed on the takeup motor to provide constant takeup tension as well. Two units can provide fast starts at 30 ips, eliminating capstan creep. The unit is designed to fit nearly all Ampex tape recorders, as well as other well known machines.
Mfr: Inovonics
Circle 54 on Reader Service Card

2940625

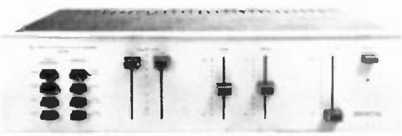
VARIABLE SPEED OSCILLATOR



● Available with an optional four-digit electronic display for exact speed accuracy, the lightweight VS-10 is specifically designed for use with the Ampex MM-1100 and AG-440 series of recorder/reproducers and can drive up to three recorders. The self-contained oscillator, powered by the capstan servo of the recorder via a single cable, features a range of ± full tone in quarter-tone steps and a coarse/fine variable speed adjustment. The readout display (110/220 vac, 50/60 Hz) may be operated either in percent of nominal speed or in frequency (50 or 60 Hz center frequency) of the associated recorder. The readout utilizes the servo's crystal reference for control.

Mfr: Ampex Corporation
Price: $795 (with optional digital readout display) $395 without.
Circle 51 on Reader Service Card

HIGH DEFINITION STEREO AMPLIFIER AND PREAMPLIFIER



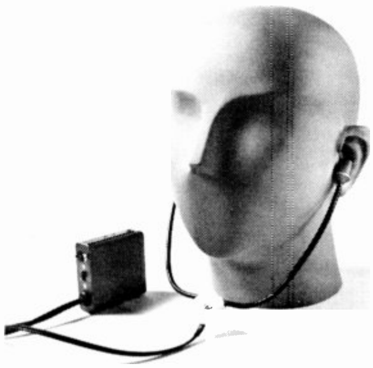
● New circuitry concepts, which it is claimed produces an effect with no discernable distortion apparent below the actual noise of the circuit, are used in the preamplifier design of HD250 integrated control amplifier and HD22 high definition preamplifier. With the tone controls in the flat position and measured over a bandwidth from 15 Hz to 23 kHz, the signal-to-noise ratio with respect to an input figure of 5mV is − 83dB. The amplifier section is capable of producing 50 watts per channel at 8 ohms, both channels driven, from 20 Hz to 20 kHz ± 1 dB, with an average of 90 watts per channel at 5-6 ohms.

Mfr: Audionics
Price: Amplifier: $695
Preamplifier: $449
Circle 52 on Reader Service Card

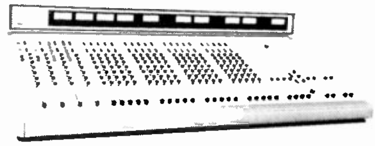
BINAURAL MICROPHONE

● Physical listening conditions are simulated with improved fidelity, according to the manufacturer, by the use of MKE 2002, a binaural microphone which fits over the recordist's ears. The unit, mounted on a stethoscope-like band over the recordist's head, contains two electret transducers which rest lightly in the ears. This permits a reproduction of all the variables present in human hearing, the structure of the head, surrounding air noise, left-and-rightness, the perception of distance in addition to differences in tone, etc. The result is not only a lifelike pickup of a performance, but also the surrounding audio ambience that would be present in an audience situation. The dual condenser microphones come complete with battery power supply, carrying case, and plastic artificial head, willing to stand in for the actual recordist if necessary.

Mfr: Sennheiser
Price: $330
Circle 45 on Reader Service Card



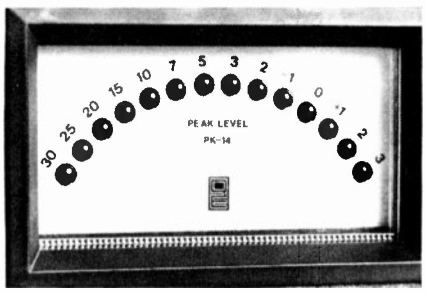
AUDIO CONTROL CONSOLE



● Input module functions present in series 20 LM console include four inputs, four pre-settable mute controls, phase switching mic and line switches and attenuation, three-knob eq., stereo pan pot, all with in/out switching. Two foldback and an echo send controls are provided with in/out switching and pre-post fader selection. The unit has conductive plastic slide attenuation, monitor solo function and on/off switch with led indicator. The stock model includes sixteen inputs (expandable to 32 inputs), quad outputs with a mono bus, stereo buses, two foldback, and one echo send bus. All ten outputs are metered. A computer ribbon cable organization permits input and output panels to be located in any board position. Additional options can be added.

Mfr: Cétec
Price: $11,500 (additional input modules $375 each)
Circle 46 on Reader Service Card

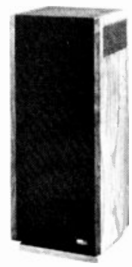
PEAK PROGRAM METERS



● All solid-state peak program meters PK-14 and PK-16 offer precise visual level indication via sequentially lighted led readouts of true signal levels. A 14 or 16 green and red segmented readout will monitor standard vu or peak level program content, depending upon the user's preference in selecting its alternate mode operation by a front panel control setting. Both units contain led brightness control, integration and decay time adjustment, input level scaling, constant current consumption, simple power supply requirements. Integration time specifications conform to European DIN 45406 for peak reading and USA C16.5—1954 for vu characteristics. The PK-14 arc-scale meter is designed to retrofit into existing 3½ inch meter installations, while the vertical scale PK-16 offers monitoring capabilities in updated or custom designed control consoles.

Mfr: Quad/Eight Electronics
Circle 44 on Reader Service Card

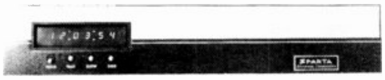
"ROCK MONITOR" AIR MOTION LOUDSPEAKER



● The requirements of modern musical forms are met by AMT 3 loudspeaker, which the manufacturer claims to offer support to the transient performance obtainable from a conventional cone bass system. Midrange and treble frequencies are handled by an air-motion transformer positioned for unhindered radiation in all directions. For lower frequencies, a six inch high compliance, high gauss midrange driver is mounted in a resistively terminated line which extends back into the bass enclosure. The lowest frequencies are served by a proper matching of the midrange to twin ten inch drivers. A carefully calculated resistance allows the drivers to continue linear operation far below system resonance and without uncontrolled motion at any frequency.

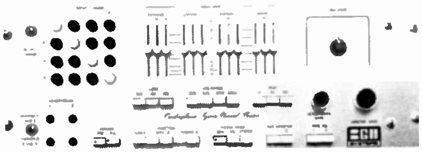
Mfr: Ess, Inc. (Heil)
Price: $435
Circle 47 on Reader Service Card

DIGITAL TIMER CLOCK



• Both a bright visual display of correct time and form "C" contact closures are provided with model DC24 digital clock. It measures 19 inches by 3½ inches high by 10 inches deep. Options include reset board (approximate time corrections up to four times per hour), net join board (exact time corrections either once or twice per hour), and oscillator time base and battery backup board, which maintain the exact time independently of line frequency variations or power interruptions. Controls on the front panel enable the operator to halt the clock altogether, advance the seconds counter rapidly, advance the minutes counter rapidly, or light the led display memomentarily when operating the DC 24 on battery.
Mfr: Sparta Electronic Corp.
Price: (With reset board) $475. Net join option: $100 Oscillator/battery backup option: $125.
Circle 41 on Reader Service Card

QUADRIPHONIC SYSTEM CONTROL CENTER



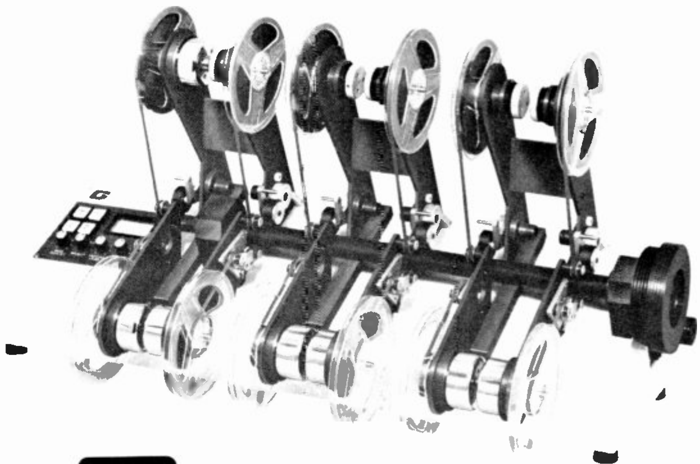
• Designed for true discrete systems of from one to four channels. model 4xPA preamplifier offers a built-in CD-4 demodulator, provisions for SQ demodulator, accommodation for 2, 4 channel tape recorders, an equalizer filter system, and a 4 x 4 matrix mode control allowing any input channel to be assigned to any output channel. The frequency response is, at high level, ± 0.1 dB, 20 Hz to 20 kHz at rated output, down −3 dB at 1 Hz and 100 kHz at rated output. The phono range is ± 0.25 dB from RIAA curve at rated output.
Mfr: BGW Systems
Price: $849
Circle 43 on Reader Service Card

AUDIO FLUTTER METER

• Designed for field operations, model 8160 portable flutter meter complies with the IEEE and DIN recommended standards, for pulse response. In addition to outside work, it can be used in hi-fi and radio repair shops, audio and video tape transports production line tests, and for servicing dictating equipment.
Mfr: 3M
Mfr: $395
Circle 42 on Reader Service Card

After you use the 1056, we'll know one thing about your dub quality: it just got better.

Professional studios that make lots of dubs for radio, welcome the speed and quality they get using the Garner 1056. It offers a whole new set of advantages for producers of reel-to-reel duplicates for radio, AV, or educational needs. Some of those are: • Single capstan drives the master and all five copies. • Solid-state electronics and special heads provide outstanding frequency response. • Two-speed drive allows either 30 or 60 i.p.s. duplicating. • Extra-fast rewind of master tape speeds production. • Unique forward tilt of transport mechanism aids threading. • Conveniently located controls feature push button operation.



GARNER ELECTRONICS
4200 NORTH 48TH STREET
LINCOLN NEBRASKA 68504

Circle 20 on Reader Service Card

Martin Dickstein

SOUND WITH IMAGES

Equipment Follow-Up

• A short time ago, we devoted a column to the care and feeding of the 16mm projector. In a subsequent column we quoted a letter we received from a reader who shared his experiences with maintaining and handling film projectors. Just a couple of months ago, this column discussed a specific film projector to introduce it to some of our readers who might not have been familiar with it. Once again, we are pleased that a reader took the time to write of his experiences with this unit, and to introduce us to another double system projector. We should like to follow up as quickly as possible this time, and then, after the letter, we'll provide some of the technical specifications for the Bauer Studio projector mentioned in comparison with the Siemans. Incidentally, sincere thanks to Mr. John M. Hoerner, Jr., Extension Editor-Visual Communications, University of Georgia College of Agriculture, Athens, Ga., for his interesting comments.

"The Siemans double sixteen projector was an excellent tool for single and double system film editing. I spent several years learning its idiosyncracies and capabilities, but it has now been replaced by the Bauer Studio projector. The mixing capability of the Siemans was often very useful, but without an external vu meter to be able to read the original track level, the overdub level was often too high or too low, and the lack of a monitor head made the process too hit or miss to be reliable for news film production. Rather than try an overdub mix, I would transfer the sound to the full coat side, and then do the mix coming back to the single system side and the sound track on the film.

"Maintaining sync when the film was removed for editing after the sound was transferred was often a problem because of the air damped idler on the full coat side. I always spliced a frame of beep tone into the leaders of the film before transfer, made the transfer, matched up the beeps on a syncronizer, then retarded the track 28 frames for editing. When the film and sound track were loaded back on the projector for transfer back to the mag. stripe, the cue punches were appropriately lined up. Then I would run the projector backwards for a few feet, and, without going into the record mode, I would run it forward and listen for the beeps. If they matched, then I would go into record and complete the transfer. I found this was the fastest and most accurate method of maintaining sync when editing.

"The removable gate of the Siemans

was a distinct advantage which was not present on the Bauer projector. During transfer operations, I would always remove the gate to prevent any additional wear on the film and to avoid the possibility of breaking a splice. If several transfer operations are anticipated, I would recommend splicing with clear Mylar tape, rather than hot splicing. Another problem created by the Siemans was electrical noise generated by a governor-controlled motor. While synchronous motors were available on the Siemans, I never knew anyone among a dozen or so machine owners who had one. The governor incorporated a set of points on the back of the motor shaft, and they would pit and burn, requiring dressing to minimize the electrical interference.

"Despite the few problems, the Siemans was an excellent projector, and one of the few I would trust to project original film without scratching. The pressure plate was made of a type of bakelite, with a floating metal plate, and a triple pulldown claw. Film could be threaded to bypass the sound head, further minimizing the chance of scratches.

"The Bauer studio projector will do everything the Siemans does, and has a few extra features, among them a synchronous motor which is standard, optional 4-channel heads, including a monitor head, and improved flutter and wow specifications. Also, once both sides of the projector are threaded, the mechanical interlock can be recoupled for syncing the tracks, while the Siemans had to be rethreaded."

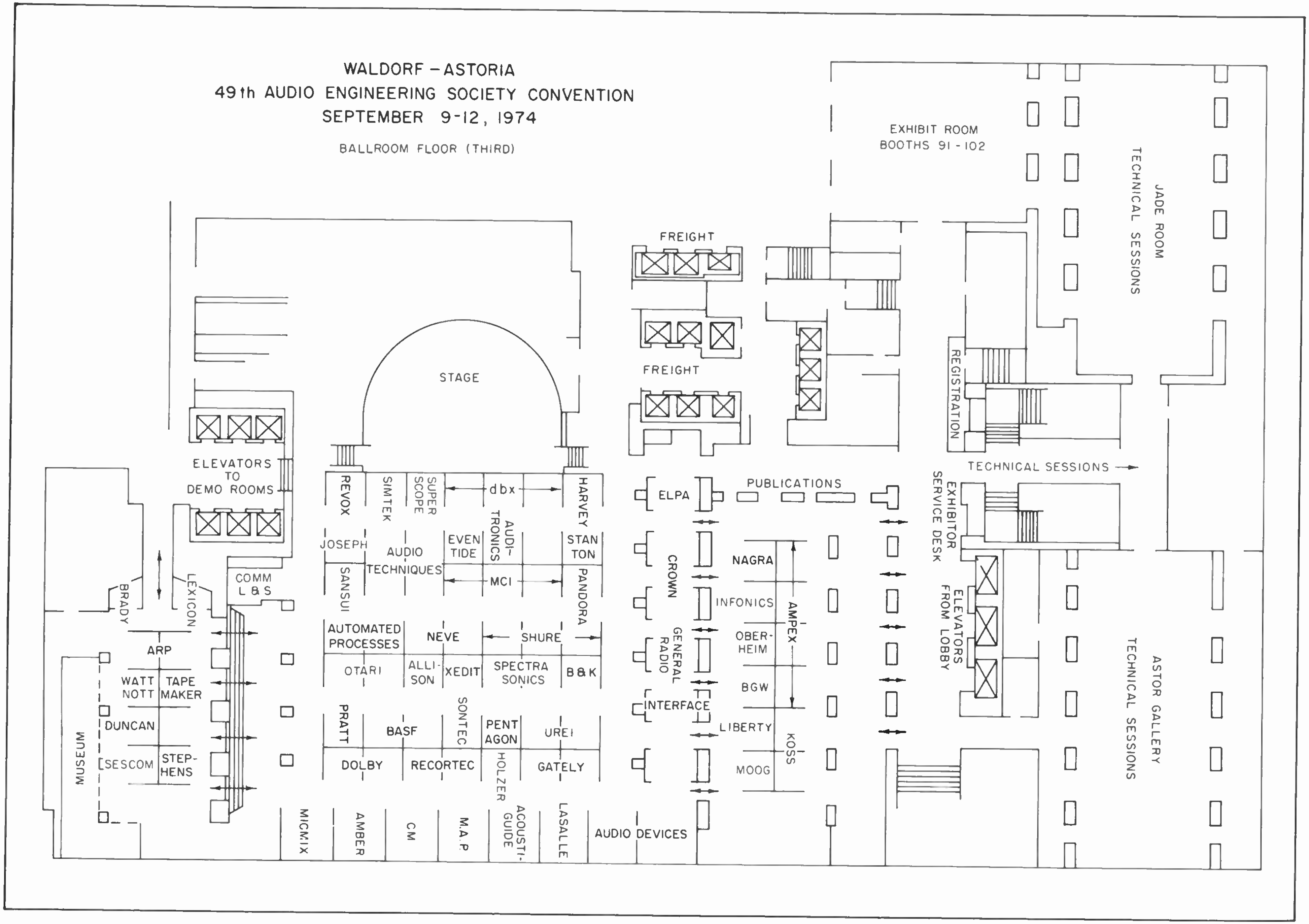
We appreciate comments like those of Mr. Hoerner which come from repeated experience, and which he is willing to share with others. It is not the purpose of this column to compare directly two similar pieces of equipment, but to introduce these units to those to whom they may be unfamiliar. The following is, then, the specifications for the *Bauer P6* studio double band projector, and these will be followed by a brief note on another similar unit, the *Sonorex 16/16*.

The Bauer has an output of approximately 500 lumens, using a 250W quartz iodine lamp, and is cooled by a double fan on the motor shaft. The drive is by synchronous motor, the take-up assembly is load controlled and self compensating for uniform winding, there is provision for fast rewind, and an automatic fail-safe switch is incorporated to stop the projector if the film should break. The film moving mechanism is a 3-toothed claw, the film pull-down ratio is 1:6.9, and the picture steadiness is plus or minus 0.1 percent.

In the sound department, provision is made to have a monitoring facility during recording. A built-in speaker is provided with a level control switch, the power amplifier is rated at 25W music power with a frequency response of 50-7,000 Hz. (plus or minus 3 dB) for the optical sound and 50-12 kHz. (plus or minus 3 dB) for mag. sound. The signal-to-noise ratio is −45dB. Wow and flutter are specified at plus or minus 0.4 percent. The amplifier output can feed an external 8 ohm speaker, and a preamp output is also provided with a 1.5 volt output at 600 ohms. The unit also has an hour timer built in.

The Sonorex 16/16 is similar to the Bauer in several aspects. It is a double system unit and has a sync motor, double flywheels with motor-driven run-up for fast start, a safety switch for end-or-break of film, an elapsed time meter, and monitoring facilities.

If anyone out there in film-editing land has had other experiences with projectors of this or any other type, or if you are familiar with any other units in the 16mm double system, please let us have your comments for others to read in this column. ■


WALDORF – ASTORIA
49th AUDIO ENGINEERING SOCIETY CONVENTION
SEPTEMBER 9-12, 1974
BALLROOM FLOOR (THIRD)
EXHIBIT ROOM
BOOTHS 91 - 102
TECHNICAL SESSIONS
JADE ROOM
FREIGHT
FREIGHT
STAGE
REGISTRATION
ELEVATORS TO DEMO ROOMS
TECHNICAL SESSIONS
EXHIBITOR SERVICE DESK
REVOX
SIMTEK
SUPER SCOPE
dbx
HARVEY
ELPA
PUBLICATIONS
JOSEPH
AUDIO TECHNIQUES
EVEN TIDE
AUDI-TRONICS
STAN TON
CROWN
NAGRA
ELEVATORS FROM LOBBY
BRADY
LEXICON
COMM L & S
SANSUI
MCI
PANDORA
INFONICS
AMPEX
ARP
AUTOMATED PROCESSES
NEVE
SHURE
GENERAL RADIO
OBER-HEIM
WATT NOTT
TAPE MAKER
OTARI
ALLI-SON
XEDIT
SPECTRA SONICS
B & K
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DUNCAN
PRATT
BASF
SONTEC
PENT AGON
UREI
INTERFACE
LIBERTY
ASTOR GALLERY
TECHNICAL SESSIONS
MUSEUM
SESCOM
STEP-HENS
DOLBY
RECORTEC
HOLZER
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MICMIX
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LASALLE
AUDIO DEVICES


Keep on Trackin'
Multi-trackin, that is, with Stephens Electronics professional tape recorder/reproducers. Our superbly designed and engineered machines are available in a variety of standard formats, from 4 to 24 tracks, or you can keep on trackin with Stephens' unique 32 track and 40 track 2-inch machines.
Pictured (front-to-rear) are the 4-track, 40-track and 24-track machines.
Battery powered portable units are also available
STEPHENS ELECTRONICS, INC
3513 Pacific Ave., Burbank, Calif. 91505 Phone (213) 842-5116
Circle 19 on Reader Service Card

SIDNEY L. SILVER

Controlled Time Delays for Speech Reinforcement Systems

Time delay applications can significantly improve the performance of a sound reinforcement system, particularly if it is used for speech improvement. The author covers such concepts in detail.

IN LARGE CONFERENCE ROOMS and assembly halls employing speech reinforcement systems, disturbing time lags are often produced when amplified speech from a nearby loudspeaker, or even a more distant loudspeaker, reaches the listener's ears well before the direct sound from a live source. The resulting sound may be perceived by the audience as discrete annoying echoes, or, when there is a profusion of echoes more closely spaced in time, as excessive reverberation. To compensate for these undesirable time lags, time-delay units are often introduced into the amplification system for the purpose of retarding the sound from a particular loudspeaker (or a grouping of loudspeakers), so that the total sound pattern is synchronized with the live sound source.

Time-delay correction, in effect, can help maintain the proper spatio-temporal relationship between natural and reinforced speech, permitting the human hearing mechanism to integrate subjectively, and hence localize the sound as coming from the *true* source. Depending upon the acoustical characteristics of the hall and the location and orientation of the loudspeaker system, time-delay units may be used to enhance the naturalness of speech, improve intelligibility, and provide a high degree of directional realism. Before discussing this subject in greater detail, however, let us examine some of the psychological and physical phenomena relating to the human auditory system, which create a demand for the practical application of these devices.

Sidney L. Silver, a frequent contributor to this publication, is with the United Nations Telecommunications Section where he is in charge of sound and recording.

PSYCHOACOUSTICAL DATA

It has long been recognized that when a number of separate sound sources (similar in content, and not too widely different in intensity) follow each other in close sequence, we attribute the total sound to that source leading in time. Subjective experiments by Haas[1] and other acousticians[2] have provided an adequate basis for understanding the psychoacoustic events involved in the human perception of speech sounds arriving from multiple transmission paths. The Haas effect, or *precedence* effect, as it is also called, has established that for successively arriving sounds with small differences in delay time, the earlier sound, by suppressing the audible effects of the later sounds, will dominate the spatial impression. For larger differences in delay time, the sounds will be heard as individual echoes, distinct both in space and time. This delay phenomenon, while primarily concerned with room acoustics, has had considerable influence on the design of speech reinforcement systems.

To demonstrate the precedence effect, two loudspeakers (connected in-phase) are placed in front of an observer in an anechoic environment. Using pre-recorded speech as the program source, the levels of both loudspeakers are adjusted for equal intensity. Referring to FIGURE 1, the primary loudspeaker represents the direct sound source and the secondary loudspeaker, a delayed version of the original sound. Here the secondary source is intended to simulate the effect of a single reflection of the direct sound under actual acoustical conditions. Relating this set-up to speech reinforcement systems, the primary sound source may be regarded as the talker, and the secondary source as the amplified speech signals.

Initially, with no delay on the secondary loudspeaker, the virtual sound image appears to emanate from a single source located at a *phantom* position between the two loudspeakers. As the sound from the secondary source is delayed (on the order of 0.5 msec), the sound image gradually shifts toward the primary loudspeaker, but the point source location is not well-defined and directional stability is rather poor. If now the time delay is increased to 5 msec, the direct sound will completely mask the delayed sound, and this effect will be maintained up to about 35 msec. Within this range of delays, the hearing mechanism is characterized by an auditory fusion period during which the primary and secondary sound stimuli seem to coalesce into a single, more intense stimulus. The ear-brain perceptual mechanism apparently fully integrates the acoustic energy from these sources in such a way that localization of the combined sound is determined by the direction of the original sound source.

As the delay is increased beyond 35 msec, the delayed sound is only partially integrated with the direct sound; the listener begins to perceive the secondary sound, but the initial sound is still localized at the primary source. Finally, at delays of about 50 msec or larger, there is a discontinuity of the sound signals and the delayed sound is heard as a separate echo of the direct sound. At this stage, listening becomes unpleasantly strained as both signals seem to arrive from different directions, thus detracting from the quality and interfering with the naturalness of speech.

In order to determine quantitatively the extent of the temporal masking process, the observer is then allowed to reduce the intensity of the direct sound as a function of varying amounts of time delay, so as to produce equal loudness from both primary and secondary loudspeakers. Under these conditions, the directional sense becomes obscured and the listener cannot distinguish which of the loudspeakers is the original source. From the curve plotted in FIGURE 2 (representing the average impressions of a group of observers), it can be seen that point source location can be maintained within most of the delay range between 5 and 35 msec, provided that the amplitude of the delayed sound reaching the listener does not exceed the direct sound by more than about 10 dB. If this criterion is met, the directionality of the composite sound will be localized at the primary loudspeaker.

We have seen that for time delays of 50 msec and greater, the listener perceives, under certain conditions, an acoustic gap between the delayed and undelayed signals, which the ear identifies as a discrete, annoying echo. In order to evaluate the extent of echo interference, Haas established certain thresholds of disturbance, the data accumulated in a medium-sized room with an average reverberation time of 0.8 seconds. As shown graphically in FIGURE 3, the percentage of listeners annoyed by the echo (even if the speech material is still intelligible) is plotted against the echo delay time for various echo amplitudes relative to the direct sound. Clearly, an echo of the same intensity as the original sound will cause 20 per cent disturbance for a delay interval of 50 msec. By reducing the echo intensity level 3 dB, the delay time can be as long as 80 msec for 20 per cent disturbance. Most importantly, if

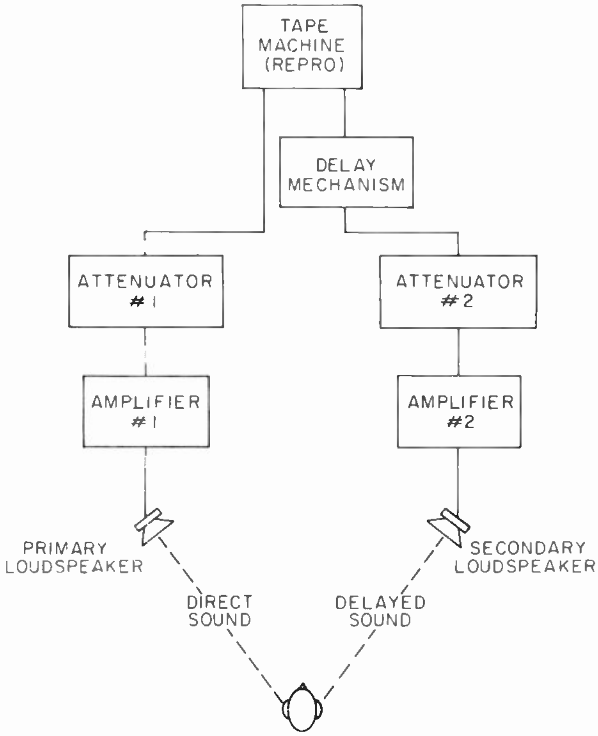


Figure 1. A block diagram of the setup used to demonstrate the precedence effect.

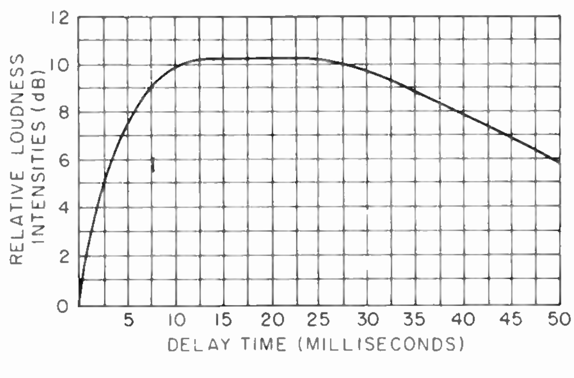
the echo intensity level is more than 10 dB below the direct sound level, it will not disturb the naturalness of speech.

It should be emphasized that these subjective experiments apply to the simulation of a single reflection of a sound source and the results are not strictly comparable with the effect of sound amplification in a hall where a multiplicity of reflections becomes an important factor. Thus, when a secondary echo is delayed beyond the critical period (50 msec), the presence of other echoes in the intervening time diminishes the disturbance of the secondary echo. Under these circumstances, the sequence of reflections useful for intelligibility may extend beyond the 50 msec limit. Nevertheless, the fundamental principles set forth by Haas are still valid, and provide the psychoacoustical basis for the optimum placement of loudspeakers in speech reinforcement systems.

ELECTROACOUSTICAL CONSIDERATIONS

Let us consider how the precedence effect operates in a

Figure 2. The relative intensities of direct sound and delayed sound for equal loudness as a function of delay time (after Haas).



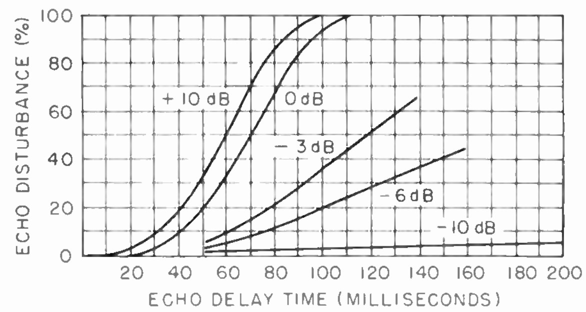


Figure 3. Echo disturbance contours for several echo intensity levels as a function of delay time (after Haas).

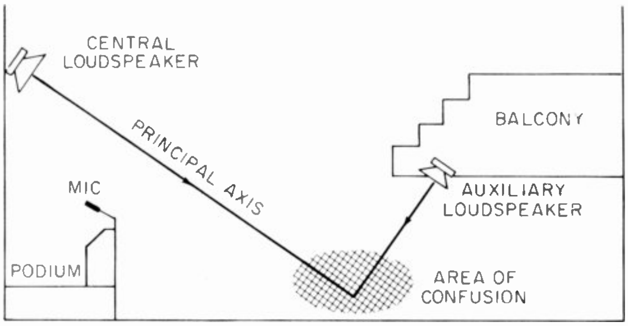


Figure 4. Echo effects produced when reinforced sound arrives at the same area from a different transmission path.

large conference room, where an amplification system reinforces a live sound source bearing a fixed spatial relationship to an audience. Assume that the talker uses a microphone at the center of a podium located at one end of the hall. To preserve directional realism, it would be necessary to arrange the loudspeaker system in such a way that the sound and visual images appear to correspond, i.e., the overall sound apparently coming from the talker with the audience unaware that sound reinforcement is being used.

Suppose, on the one hand, that the sound reinforcement system employs two loudspeakers, one on either side of the hall near the podium area. With this split speaker configuration, many listeners (especially those at the sides) will hear one or the other of the loudspeakers a few milliseconds before they perceive the live sound source. This situation often results in an unnatural aural-visual effect, where the ears tend to concentrate on the sides of the hall, while the eyes focus on the talker at the podium. Consequently, the directional sense of the listeners becomes ambiguous and confused, possibly leading to mental fatigue, over a period of time. In certain cases, where the left-and-right loudspeaker placement is very wide, the sound from the more distant loudspeaker will be heard as an artificial echo of the sound from the nearer loudspeaker, thereby reducing speech intelligibility.

The use of a single-source loudspeaker system, on the other hand, will ensure that sight and sound are similarly oriented. By mounting a centralized loudspeaker (or loudspeaker cluster) directly above the talker, say, 20 or 30 feet, a uniform sound coverage pattern can be provided throughout the audience seating area. High intelligibility and naturalness of speech are achieved because of the similar transmission path length between live sound and reverberant sound, relative to the listeners. In a properly designed system, the directional characteristics of the loudspeaker array are controlled by an amount dependent upon the reverberant characteristics of the hall. According to the precedence effect, if the amplified sound from the central loudspeaker system arrives at the listener's ears slightly after the live sound (between 5 and 35 msec), and the reinforced level is no greater than 10 dB above the direct sound, the live sound will take command and indicate to the listener the direction of the sound source.

The arrival-time effect produced by a single-source loudspeaker system above the talker is aided by the fact that our hearing mechanism is marked by good horizontal resolution but relatively poor vertical resolution; hence localization of a sound source is much more precise in a lateral direction as compared to vertical directivity. Since our ears are located in a horizontal plane, we are thus able to estimate the direction of a horizontally displaced sound source with considerable accuracy. By contrast, vertical displacement is rather difficult to judge with certainty. This means that when a centrally located loudspeaker reproduces acousic energy derived from the live sound source below, the listener instinctively identifies the visible talker as the origin of the blended sound.

TIME-DELAY CORRECTION

In order to attain good intelligibility at the rear of a large hall, the centralized loudspeaker cluster would have to operate at a sufficiently high level without producing dis-

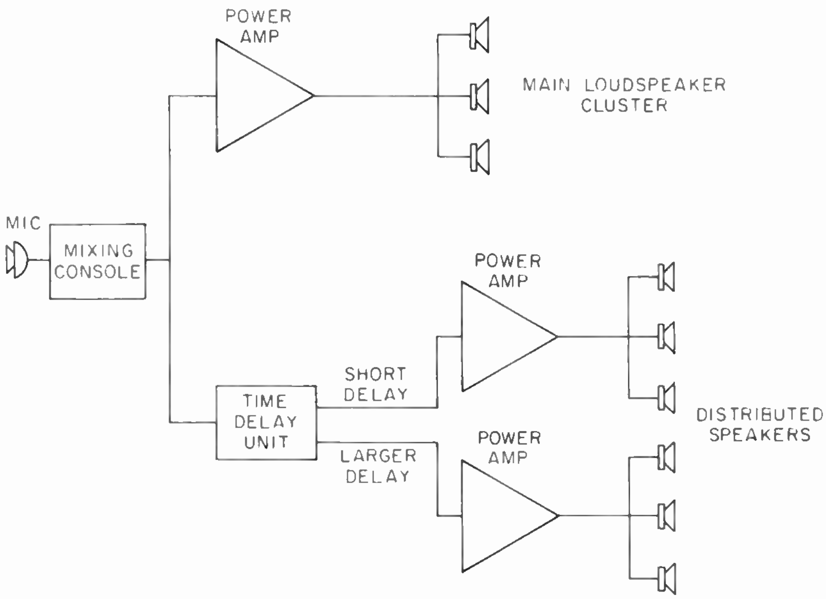


Figure 5. A time delay unit inserted between mixing console and auxiliary power amplifiers.

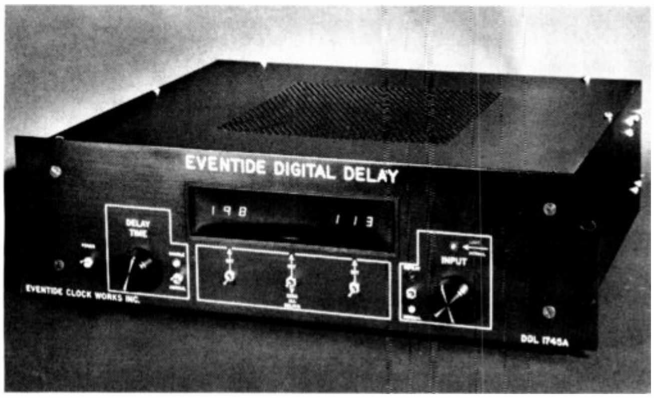


Figure 6. One of several such products available, this Eventide model 1745A Digital Delay System provides delays up to 398 msec.

turbing echoes from reflecting surfaces. Because of room geometry, it may be necessary to supplement the main system with auxiliary loudspeakers throughout the more distant seating areas, for example, where sound coverage must be provided under deep balconies not reached by the central system. In the example shown in FIGURE 4, the use of a supplementary loudspeaker positioned under a balcony overhang may give rise to an area of interference, or overlap zone, immediately in front of the balcony area. Here the listener will hear first the amplified sound from the nearest auxiliary loudspeaker, followed by the reinforced sound from the main loudspeaker cluster. The resulting interraction between the two sound sources produces a disturbing echo-effect which greatly reduces intelligibility. Furthermore, directional realism is usually lost, especially for those listeners in the back area covered solely by the supplementary loudspeakers.

The time lag problem occurs because acoustic energy in the form of electrical signals travels much faster through cables than sound energy in the form of pressure waves in the air. If, for example, the propagation velocity of airborne sound is taken to be 1130 feet/sec, then the wavefront will advance one foot in 0.885 msec. Thus, for airborne sound to travel, say, 100 feet from the main system to the balcony area, it takes a transit time of 88.5 msec to reach the listener. Assuming that the balcony loudspeaker is 10 feet from the listener, it takes 8.85 msec for this airborne sound to be perceived. Since the propagation time of electrical signals through wires is virtually instantaneous, the listener initially hears the main signal delayed by 88.5 msec, followed by the supplementary signal delayed by 8.85 msec, the time difference being 79.65 msec. Note that the distance between the talker and the microphone is neglected because this transmission path is common to both sound sources.

The precedence effect has established that the interference, or annoyance effect of time-delayed sounds, is influenced by both the difference in arrival times and the relative intensity between the various sounds. Hence, if a suitable time-delay mechanism is inserted into the auxiliary loudspeaker system to produce a delay of 79.65 msec plus, say 20 msec, then the overall sound energy will be additive so as to ensure high intelligibility. Moreover, since the arrival times of both sources will appear to be coincident, no confusion or lack of realism will result. This acoustic illusion will persist even when the sound level of the supplementary signal (time-delay corrected) is greater than the main signal. FIGURE 5 shows a simplified block diagram of a time-delay unit, with two outputs serving distributed loudspeaker groupings at different locations from the main system.

An entirely different approach to loudspeaker placement is the totally distributed system often used in highly reverberent rooms. Instead of a main cluster, a number of loudspeakers are suspended overhead at varying distances from the podium. The loudspeakers are brought within about 12 feet from the listeners' ears, and appropriately spaced to provide even coverage throughout the entire audience seating area. To overcome the time lag problem, time-delay devices are introduced into each loudspeaker system, the delay intervals corresponding to the various distances from the podium. This application of progressive time-delay correction not only improves the apparent acoustics of the hall, but effectively synchronizes the arrival times of the amplified sound with the live sound source. Distributed loudspeaker systems are also utilized in halls where a centralized system is not practical, e.g., low-ceilinged rooms, where a central loudspeaker could not be positioned high enough above the talker to deliver enough gain without the danger of acoustical feedback. In this situation, the loudspeakers are usually flush-mounted in the ceiling, each speaker providing a limited area of coverage to avoid mutual interference.

An alternate scheme employs a comparatively large number of small seat-back loudspeakers operating at low sound levels, and spaced close enough to serve, say, three listeners. Here suitable time-delay units are inserted into the amplifying chain to ensure that all reinforced sound reaching the listeners is perceived simultaneously with the live sound source. Speech signals are so delayed that the live voice from a fixed source passes over the first few rows of seats slightly before the corresponding amplified sound is emitted by loudspeakers in those rows. Similarly, the succeeding rows receive the signals with increased-time delays until the entire room is covered. The time-delay mechanism, in this application, must be capable of producing enough separately controlled delayed outputs for a single input, so that directional realism is assured for all listeners.

TIME DELAY UNITS

In past years, magnetic tape recording systems (employing tape loops or discs) and acoustic-pipe devices have formed the basis for time-delay correction. But owing to the inherent limitation of these methods, the control of time lag in sound reinforcement systems is now being handled by digital delay lines. These recently developed digital systems have been made practical by the application of lsi (large-scale integration) techniques, which allow a multiplicity of complex circuitry to be incorporated into a small space.

In operation, the digital delay line transforms the analog audio input information into digital form, stores it for the desired delay time, and finally re-converts it into an audio output signal for transmission to various loudspeaker systems. A commercially available digital delay line is shown in FIGURE 6. This unit has two independent outputs, each providing up to 199 msec of delays in one msec steps; or, by means of a doubling switch, up to 398 msec in 2 msec steps. In addition, optional modules can be plugged into the unit, not only to increase the number of independent outputs available for any given delay line, but to increase the total delay time available for each output. ■

REFERENCES

1. H. Haas, "Uber den Einfluss eines Einfachechos auf die Horsamkeit von Sprache," *Acustica*, vol. I, 1951, pp. 49-58, English translation by Dr. Ing, K. P. R. Ehrenberg quoted in "The Influence of a Single Echo on the Audibility of Speech," *Journal of the Acoustical Society of America*, vol. XX, March, 1972, pp. 145-159.
2. H. Wallach, E. B. Newman, M. R. Rosenzweig, "The Precedence Effect in Sound Localization," *The American Journal of Psychology*, vol. LXII, July, 1949, pp. 315-336.

MICHAEL RETTINGER

Recording Studio Acoustics

This is the first installment of a six-part series that will appear in these pages in alternate months beginning with this issue.

ALL ENCLOSURES intended for the recording of vocal and instrumental music have certain acoustic elements in common. Recording studios are like people—no two of them alike—and, like people, they can function only under certain common conditions. It is the purpose of the following to discuss some of these requisites.

A recording marred by noise is a recording lost. Rather than exhilerating the listener it may annoy him. Interfering noise is like having a deep scratch on a disk. A sophisticated noise remover can clean up the intervals between the words or the notes but it can do nothing to polish the signals themselves.

It is surprising how few studio designers initiate their work with a noise exposure level measurement of the proposed site, or existing building, if it is to be converted into a studio. Note the words *noise exposure level*, rather than *noise level* measurement. The difference lies in that the former quantity represents a noise history—a variation of noise level with time—while the latter may consist of no more than the observation of a sound-level meter needle deflection during a momentary auditory disturbance at the site.

Every one of the three recent acoustic designs by this investigator of large California recording facilities—the Burbank Studios in Burbank, representing the merger of the Columbia Pictures Corp. and the Warner Bros. Studios; the Audio-Visual Complex of the U.S. Air Force at the Norton Air Force Base in San Bernadino, and the Recording Studios of the U.S. Navy in San Diego—was preceded by a 24-hour graphic level recording of the acoustic climate surrounding the proposed construction area.

Municipal, state, and federal noise exposure level data of a given area are generally in terms of the A-weighted sound level, since this quantity correlates well with people's subjective judgment of the annoyance of many types of noise. This is true also of the *Perceived Noise Level*, which is employed to map airport environment noisiness in terms of PNdBs. What is needed for building insulation requirements is the sound pressure level characteristic and history of the noise, that is, its variation with frequency and its variation with time. One can always obtain the A-weighted sound level characteristic from the sound-pressure level spectrum, but the inverse process is not possible.

Noise histories should be expressed in decile levels ob-

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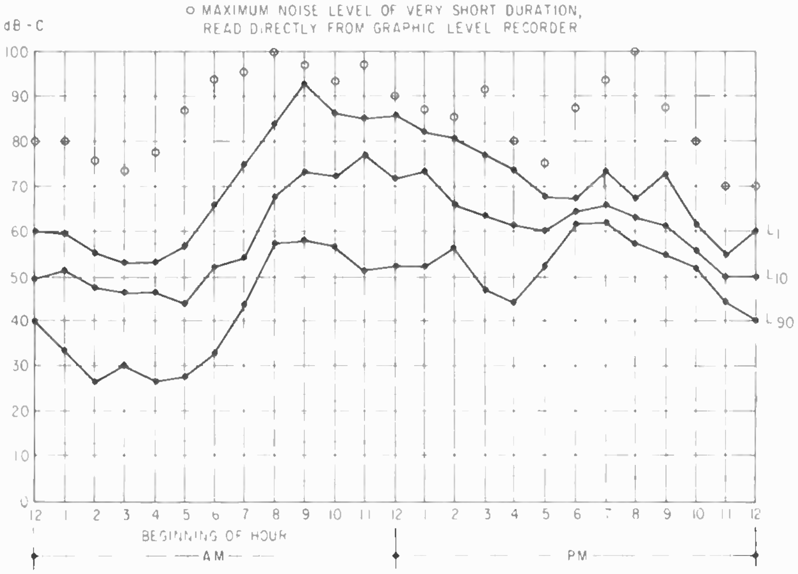

Figure 1. Variation of sound-pressure levels exceeded 1 per cent (L_1), 10 percent (L_{10}) and 90 percent (L_{90}) during the 24-hour noise level history of a proposed sound-recording studio site, together with momentary maximum noise levels, which could possibly be encompassed in a L_1 decile level exceeded 3.6 seconds per hour.

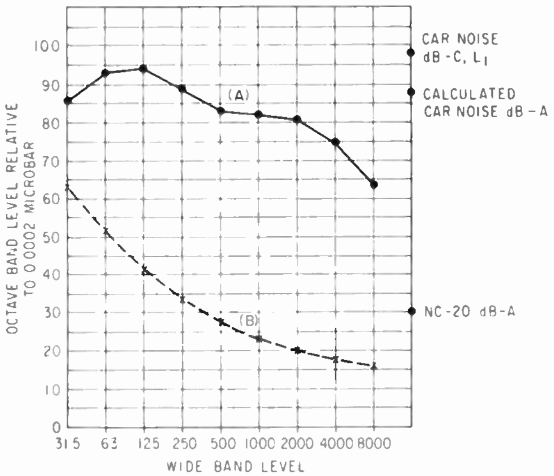

Figure 2. L_1 spectrum of noise at an intended studio locale (A), and Noise Criterion 20, or maximum permissible noise level characteristic in a recording studio (B).

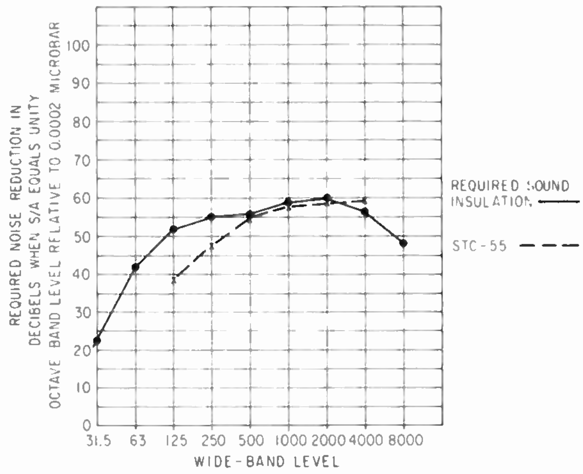

Figure 3. Required sound-insulation characteristic of studio boundaries, graphically determined from the noise level displayed in Figure 2.

tained with a statistical distribution analyzer, and the measurements should be carried out with the "C" weighting network in the common sound level meter. Thus, L_{90} is the decile noise level exceeded 90 percent of the time during the observation period; L_{50}, the level exceeded 50 percent, and L_{10} that exceeded 10 per cent of the test duration.

FIGURE 1 shows a graph to which both the direct reading and the statistical methods of noise exposure level assessment have been applied in a 24-hour recording at a proposed recording studio site. In the evaluation of such information one must note, for instance, whether a given L_1 level transmission into the studio can be accepted 1 percent of the time, that is, 36 seconds per hour, or whether an acoustic compromise cannot be allowed. While such an intrusion may not be permitted in a recording studio, it may but rarely be responsible for a bad "take" in a motion-picture sound stage where scenes are photographed once every two hours or at even greater intervals. For this reason, there are still film-recording studios in Hollywood which permit three-times daily low overflights of traffic-reporting helicopters, which can be heard inside the building.

Curve (A) of FIGURE 2 shows the L_1 spectrum of a noise environment whose wide-band sound-pressure level is 98 dB-C and whose calculated A-weighted sound level comes to 88 dB-A, which conforms to the California Vehicle Code noise level limit of a 35 mile/hr. truck at 50 feet.

Curve (B) of FIGURE 2 represents the NC-20 criterion, or maximum acceptable noise level characteristic inside a recording studio, whose wide-band sound level is 30 dB-A.

The difference between curves (A) and (B), shown on FIGURE 3 constitutes the required sound insulation characteristic of the studio's external boundaries under the restriction that S/A, the ratio of the boundary surface to sound-absorption in the studio, is unity (a frequently-met condition in such structures) and that all boundaries are exposed to the same noise level.

Because the 500 hertz noise-reduction necessary for the walls and roof of such a building comes to 55 dB, the less knowledgeable architects and designers are tempted to specify a sound insulation rating of STC-55 (Sound-Transmission Class 55) for the boundaries. However, as drawn in on FIGURE 3 with a dotted line, such a sound attenuation would be inadequate for these space-dividers. Of course, the ASTM (American Society for Testing and Materials) notes in its standard E413-70T) that excluded from the scope of this classification system are the exterior walls of buildings, whose noise problems are most likely to involve motor vehicles or aircraft.

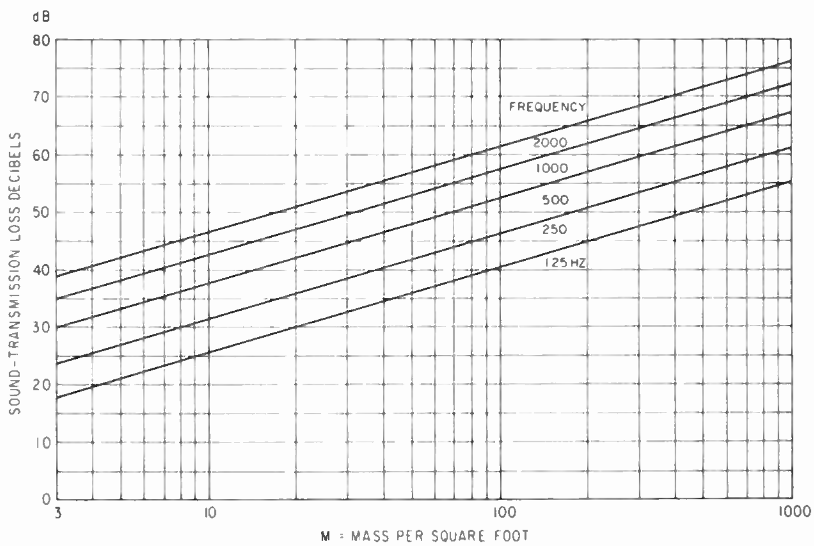

Figure 4. Acoustic Mass Law, or variation of sound-transmission loss with surface density (mass per square foot) of building boundary, for several frequencies.

FIGURE 4 illustrates the so-called *acoustic mass law*, an empiric finding, proposing that the mid-range, or 500-hertz sound-transmission loss, of a barrier varies according to

$$TL = 23 + 14.5 \log M$$

where M = surface density of wall, lbs./sq. ft.

Accordingly, a monolithic barrier, to exhibit a sound-transmission loss of 55 dB at 500 hertz (as called for by the curve shown on FIGURE 3), would have to have a surface density of 160 lbs./sq. ft. Since this represents a concrete wall more than 12 inches thick, recourse is taken to double barriers. A discussion of the sound-insulation of double walls will be found in the author's book *Acoustic Design and Noise Control*, available through the office of **db**.

A low noise level in a recording studio is also dependent on the type of air-conditioning system equipment installed in the building. For such rooms, an air-velocity of no more than 500 ft./min. is recommended, because higher air speeds invariably produce turbulency at the diffusers. This condition cannot be corrected after construction by the introduction of duct silencers, or short duct sections with sound traps. The reason is that the noise is not a fan hum carried through the line, but aerodynamic hiss at the duct ends. The size of a required duct depends on the number of air-changes per hour desired in the studio. A high number of such changes in a large studio, like 10 changes per hour in a room of more than 50,000 cubic feet volume, calls for relatively large ducts when the air velocity is low (for which reason subsequent alterations are frequently impossible because of space limitations in the walls).

A studio also must look right to be right. I well remember the time I was called to a major motion picture studio in which the diva had refused to sing because the stage looked, she had said, like a cow barn. The supervisor of the sound department had quickly converted a sound stage (a large stage in which sets are erected and photography takes place) into a music- and song-recording locale by placing a number of fir plywood panels about the walls and near the ceiling. According to his measurements, the acoustics of the room were excellent, and some sample recordings made by his staff prior to the recording session substantiated his results. Yet, the musicians were not happy and the diva was furious. It took me, a well-known interior decorator, and a working crew of six, the better part of two days to convert the locale to an esthetically pleasing and acoustically satisfactory recording milieu.

I was also called into a new recording studio which featured hand-rubbed hardwood panels, ¾-inch plush carpet, and other elegant trappings which made a beautiful interior decor but in which the recordings left a great deal to be desired even afer hours of experimental microphone placements for best sound pick-up. The brave but inexperienced designer of the studio had oriented the stage panels incorrectly, so that instead of providing a suitable efflux for the music, the sound was sent back into the stage to mill around therein for the confusion of the musicians and to the detriment of the recordings. Surprisingly, by merely positioning the band at the opposite end of the stage, the recordings were much improved. Finally, the entire room had to be re-worked, at no little expense. The moral of the story is that it is much cheaper to do it right in the first place.

Other common studio requirements will be discussed in the next installment. ■

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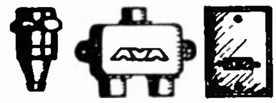

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FOR SALE: SIXTEEN LIKE NEW ITI Parametric Equalizers; free power supplies & custom Formica equipment cabinet with purchase of all sixteen. Also available, one MCI JH-16 16-track recorder with auto-locator, mint condition. Contact: **Alan Kubicka, P.O. Box 556, Medinah, Illinois, 60157. Phone: (312) 529-1001.**

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WANTED: MCINTOSH MC-75 or McIntosh MC-275. Pay top price. Call anytime. **(219) 938-8779.**

PROFESSIONAL AUDIO LINES wanted for quality audio firm catering to professional customers in entire state of New Jersey. Knowledgeable, experienced staff with full service facilities. Write details to **Box 71, db Magazine, 980 Old Country Rd., Plainview, N.Y. 11803.**

PEOPLE, PLACES, HAPPENINGS

db HAS MOVED

Sagamore Publishing Co. Inc. has finally had to move to larger quarters. We held out for as long as we could, but when the publisher walked in one day and found his desk appropriated by a new secretary he got the message.

Our new "luxurious" offices are only a short distance away at:

1120 Old Country Rd.
Plainview, N.Y. 11803

We have been able to retain the same telephone number—**(516) 433-6530.**

If you are in the area we would be delighted to have you visit us.

● Three executives have been promoted at **Shure Brothers, Inc. of** Evanston, Illinois. **Raymond E. Ward** assumes new duties as vice president, sales and marketing promotion. **Howard T. Harwood** has been named manager, marketing promotion, in charge of all advertising and public relations. **Norman A. Hesslink, Jr.** has been promoted to advertising manager, a liaison post between the company's own advertising department and its advertising agency.

● Expansion of its sales operations has been marked by the **Scully/Metrotech** recording divisions of **Dictaphone Corporation,** Mountain View, California, with the establishment of a new position, national sales manager. **Homer Hull** has been appointed to the post. Mr. Hull has been with Scully/Metrotech since 1972. Prior to that he was with **Ampex Corporation.**

● A novel sales presentation idea, called the **Suitcase Seminar** and originated by **James B. Lansing Sound, Inc.,** has branched out from its original intent and found interest in educational applications. The presentation consists of cutaway speaker components, flip chart, and audio-visual equipment, all packed into a standard size aluminum suitcase. Recently, **Tom Frisina** and **Ron Cotterell** were invited to the **University of California at Santa Barbara's** *Introduction to Audio* class. Their vivid presentation, with the aid of the suitcase demonstration, was well received for its effectiveness.

● As we went to press with this pre-AES show issue we have been saddened to learn of the following deaths:

Dorothy Spronck, administrative secretary of the **Audio Engineering Society,** succumbed to the effects of a stroke which she had suffered earlier. Death occurred on July 29.

Howard Holzer, president of **Holzer Audio Eng. Co.,** was killed in a Mexico City airplane crash. Mr. Holzer, who was an experienced pilot, was at the controls of a private plane at the time of the crash.

William (Bill) Hazlett), who many remember as **Altec's** New York office man, died in late July. He was born in 1901. He was a life charter member of the AES since 1970.

We knew and worked with these three people. We feel their loss personally and know that this emotion is shared by many.

● **Thomas Creighton III** has been appointed director of sales and marketing by **Broadcast Electronics, Inc.** of Silver Springs, Maryland. Mr. Creighton will supervise the sales of the Spotmaster line of tape cartridge machines, audio consoles, and related audio products. Mr. Creighton was formerly associated with **McMartin Industries.**

● According to a new **FCC** ruling, f.m. stations will be permitted, without notification or application to the Commission, to incorporate a combination of Dolby B-Type noise reduction and reduced pre-emphasis (25-microseconds instead of 75-microseconds) in their transmission. The system, devised by **Dr. Ray Dolby,** reduces pre-emphasis, the amount by which high frequencies are boosted during transmission without the handicap of dullness. The system is entirely compatible to existing equipment. It can be received with some improvement in quality by consumer receivers not equipped with the noise reduction units and with greatly heightened effectiveness by those consumers whose sets are equipped with the Dolby system.

● A new firm, **Joel Associates,** of Teaneck, N.J., has been formed by **Irving Joel,** formerly chief engineer with **A & R Recording, Inc.** Mr. Joel will maintain his connection with A & R as a special projects consultant. He has been responsible for the design and construction of numerous recording and sound reinforcement systems and special equipment for theater and night club entertainers, as well as maintenance for recording studios. Joel Associates will introduce a new audio test equipment line in the fall.

If you work with microphones, you need this book!

The most important microphone book ever published.

COVERS EVERY SIGNIFICANT ASPECT OF THEORY AND USE FROM A TO Z!

At last, the whole field of microphone design and application has been prepared and explained in one concise, fact-filled volume by one of audio's outstanding experts. This book is complete, up-to-the minute and so full of useful information, we think you'll use it every time you face a new or unusual microphone problem.

Perfect for Reference or Trouble-shooting
The twenty-six fact-packed chapters in this indispensable volume cover the whole field of microphones from theory, physical limitations, electro-acoustic limitations, maintenance and evaluation to applications, accessories and associated equipment. Each section is crammed with experience-tested detailed information. Whatever your audio specialty – you need this book!

Along with down-to-earth advice on trouble-free microphone applications, author Lou Burroughs passes on dozens of invaluable secrets learned through his many years of experience. He solves the practical problems you meet in day-to-day situations. For example:

* **When would you choose a cardioid, omni-directional, or bi-directional mic?**
* **How are omni-directional mics used for orchestral pickup?**
* **How does dirt in the microphone rob you of response?**
* **How do you space your microphones to bring out the best in each performer?**

This text is highly recommended as a teaching tool and reference for all those in the audio industry. *Price: $20.00*

THE AUTHOR

Holder of twenty-three patents on electro-acoustic products, Lou Burroughs has been responsible for extensive contributions in the development of the microphone. During World War II, he developed the first noise cancelling (differential) microphone, known as the model T-45. Used by the Army Signal Corps, this achievement was cited by the Secretary of War. Burroughs was the creator of *acoustalloy*, a non-metallic sheet from which dynamic diaphragms are molded. This material made it possible to produce the first wide-range uniform-response dynamic microphone. Burroughs participated in the design and development of a number of the microphones which have made modern broadcasting possible – the first one-inch diameter wide-range dynamic for tv use; the first lavalier; the first cardiline microphone (which ultimately won a Motion Picture Academy award) and the first variable-D dynamic cardioid microphone. He also developed the first wind screens to use polyester foam. Burroughs was one of the two original founders of Electro-Voice, Inc. He is a charter member of the Society of Broadcast Engineers and a Fellow member of the Audio Engineering Society.

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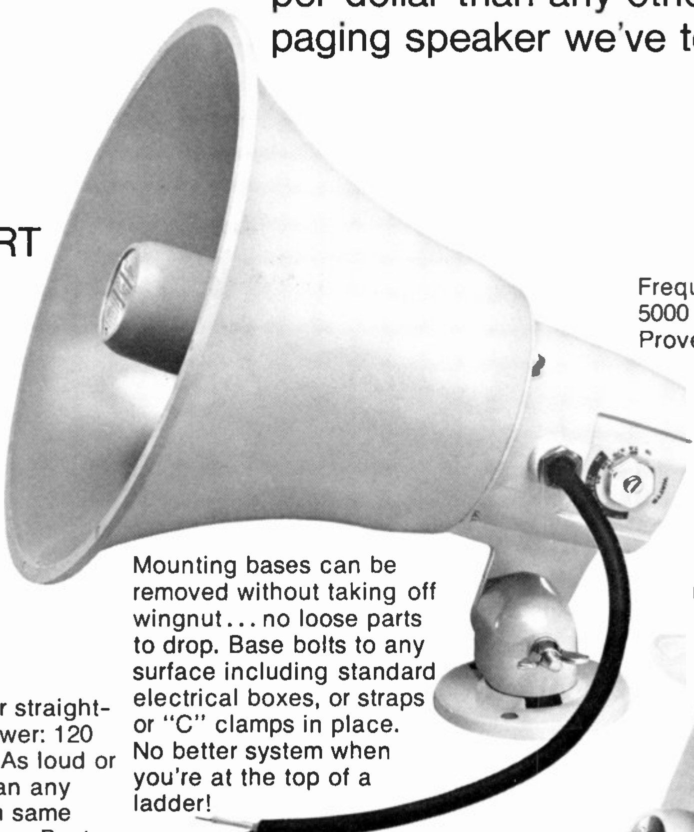

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